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THESIS

A PROPOSAL OF LOGISTICS DEVELOPMENT
FOR
REPUBLIC OF KOREA ARMY

by

Kim, Young Hoo
and
Kim, Tae Kyo

December 1984

Thesis Advisor: M. G. Sovereign

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T223448

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A Proposal of Logistics Development for Republic of Korea Army		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis December 1984
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Kim, Young Hoo and Kim, Tae Kyo		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93943		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93943		12. REPORT DATE December 1984
		13. NUMBER OF PAGES 154
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Environment, Relationship, Military Power, Uncertainty, Logistics, Evolution, Integrated Logistics Support, Readiness, Life-Cycle Cost, Cost-Effectiveness, Cost Estimating, Acquisition

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The main objective of this research is to propose some directions concerning logistics development for the Republic of Korea Army (ROKA). In particular, it concerns modern concepts such as integrated logistics support (ILS). Traditionally, Korean logistics has been treated as secondary. But, in the current situation, attention must be placed on Logistics.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

S N 0102-LF-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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A Proposal of Logistics Development For Republic of Korea Army

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MASTER OF SCIENCE IN MANAGEMENT

from the

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ABSTRACT

The main objective of this research is to propose some directions concerning logistic development for the Republic of Korea Army (ROKA). In particular, it concerns modern concepts such as integrated logistics support (ILS). Traditionally, Korean logistics has been treated as secondary. But, in the current situation, attention must be placed on logistics.

This thesis introduces historical and geographical circumstances of the Korean peninsula and appraises military problems, especially logistics. It compares South and North Korea's military powers and then analyzes the relationship between ROK and US. It proceeds with setting the concept of modern military logistics and explaining some ILS aspects concretely. It gives insights to logistics in the system life cycle including approaches to the cost-side as well as to effectiveness. For the decision-maker, the life-cycle cost (LCC) model should be considered during the acquisition cycle to assure proper logistics development.

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I. INTRODUCTION

The logistic system concept and the technology of logistics have made remarkable progress and also gained substantial attention among business executives during the last two decades. Also, the systems approach in looking at logistics has been recognized within industry and throughout the business world. Logistics is now considered to be a productive functional area that can be managed to increase the profitability of a company.

Traditionally, in their effort to reduce cost and improve profit, businessmen concentrated their effort on the manufacturing part of the enterprise. Production techniques were constantly improved; however, the efforts to reduce costs within the field of production in many companies have reached a point where relatively little can be gained. Consequently, business managers now turn their attention to the non-manufacturing operations will include functions such as procurement, transportation, warehousing, inventory control and material handling, all of which are considered integral parts of logistics.

Needless to say, in non-profit oriented organizations, especially in Republic of Korea Army (ROKA), the logistics function has become a major part of the activity, both in terms of scale and importance. A well organized and properly managed logistics system is essential for the ROK Army in order to carry out his missions in peace time as well as war time.

Considerable time and efforts have been devoted toward the development of credible military strategic and tactical doctrines to define ROK national defense. Various strategies are continually under review to find better methods of projecting military power. But through this process logistics has long been relegated to a category of secondary importance. In many cases, the crucial logistics problems are considered as troublesome jobs, and then they are much less interested, investigated and resolved in our country.

Moreover, the systems approach in looking at logistics involved designing it and managing it as a whole function rather than as a series of discrete, independent ones. If their independence and interrelationship are not recognized, sub-optimization will often occur with a resulting reduced efficiency and overall results for the organization.

One way to avoid the above and to improve the way of thinking and the organizational performance would be to integrate the system and to inform and educate the members of the organization about existing theories and ideas within the field. A review of historical and current logistical realities, and their impacts on readiness will reinforce the critical necessity to examine logistical implications. But in analyzing any subject, it might be desirable to reduce it to simple terms and to show them in logical relationships.

This thesis research is based on published definitions and explanations of the concept of military logistics. The purpose of this thesis research is to analyze the environment of current Republic of Korea (ROK) military and it's military problems, and to develop the modernized concept such as Integrated Logistics Support (ILS) and Life-Cycle Cost (LCC) model.

Chapter two deals with the reality of Korean peninsula and the relationships between ROK and US. It also describes the military problems such as military imbalance and uncertainty, and suggests some alternatives.

Chapter three is concerned with setting the concept of modern military logistics which indicates the appropriate directions for ROK military improvement.

Chapter four describes the background and concept, the explanation of elements, and the application and planning process of ILS. This chapter emphasizes the training aspects of the ILS personnel and the teamwork and some considerations in readiness.

Chapter five studies the logistics in the system life cycle and the cost-effectiveness analysis during acquisition process. This chapter illustrates application of Life-Cycle Cost (LCC) model to appraise cost-side for decision-maker.

The authors gratefully acknowledge the direction and guidance of their advisor, Professor M. G. Sovereign, and co-advisor, Professor P. M. Carrick in completing this thesis. In particular, the authors are very thankful to the colleagues and families for their helpful advice, criticism, and encouragement.

II. THE ENVIRONMENT OF R.O.K. MILITARY

A. THE REALITY IN KOREAN PENINSULA

1. The Strategic Location and Worth

Korea is located in the heart of the Far East. This fundamental fact of geographic location has always been a major factor in Korea's history. Surrounded by the major powers of Asia and the Pacific - each vitally interested in controlling the strategically located country - Korea has become many times a battleground in a struggle for power. To the southeast, only 120 miles distant, lies Honshu, the principal island of Japan. To the west, at about same distance, lies the Shantung peninsula of China. Manchuria, the northerneast province of China, shares most of Korea's northern boundary. Finally, in the northeast, for 11 miles along the Tumen River, lies the Soviet Union. As a peninsula it has served as a bridge between powers on the continent of Asia and powers in the Pacific. [Ref. 1: p. 3]

In other words, a peninsula location has both the advantage of easy access to adjacent culture when our nation was strong and the disadvantage of becoming the target of aggressive neighbors when our nation was weak [Ref. 2: p. 13].

Historically, we can find out the latest main events related to strategic location of Korean peninsula. About 360 years ago, the Japanese dictator, Hideyoshi, dreamt of conquering China, but these dreams were shattered on the Korean land bridge, partly because of the attacks by Koreans on the Japanese communication lines. However, by the end of nineteenth century, when Japan was developing into a modern power, the political, economic, and military pressure was renewed, and Japan got its first foothold on the continent of Asia by taking over Korea. Some of the battles of the Sino-Japanese war of 1894-95 were fought on the plains of Korea. Ten years later Japan came into conflict with Russia, and again the Korean peninsula was the scene of battle between its aggressive neighbors. After a short protectorate, Japan annexed Korea outright in 1910, and Japan possessed Korea for the next thirty-six years. [Ref. 1: p. 6]

On August 15 1945 , the Korean peninsula was divided into two Koreas at the 38th parallel. It was initially designated to serve simply as a line of demarcation for the acceptance of Japanese surrender by Soviet and American troops. But the line - a line of convenience - soon hardened into a solid boundary. This line was become as the "international frontier" between the Communist-dominated world and the Free world. [Ref. 1: p. 7]

On June 25 1950, The North Korean troops swept across the 38th parallel, slicing in four columns into the South Korea with the aim of destroying the ROK government. The Korean War immediately became a matter of world interest because of the importance of Korea's geographical location. The simple fact of geographical location once more became fundamental in Korea's history. [Ref. 1: p. 7]

These days, the Korean peninsula is recognized as one of dangerous areas in the world. The danger from the region is underscored by the Soviet Unions' shooting down of a South Korean civilian airliner and by the North Korean's aggressive attitudes: invasion tunnels dug under the demiliterized zone (DMZ),[1] ambushes ROK and US soldiers, subversive efforts, a constant stream of bellicose propaganda from

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[1] North Korea uses tunnel operations under the DMZ as part of their overall concept of war. Three large tunnels have been discovered under the DMZ and as many as 17 others are suspected.

Radio Pyongyong and provocative incidents such as the Rangon bombing as a recent evidence. [Ref. 3: p. 29]

However, someone argued that the division of Korea satisfies at least the minimum requirements of all of the great powers with interest in Korea [Ref. 4: p. 5]. In other words, the Korean peninsula can be recognized as a very important buffer zone between Communist powers and Free powers.

Specifically, the Korean peninsula is the one area in the Northeast/Western Pacific Basin where the interests of the four major regional powers - Japan, Peoples' Republic of China, USSR, and US - intersect directly and significantly [Ref. 5: p. 69]. The maintenance of the peace and security on the Korean peninsula is "essential" to peace and security of East Asia, including Japan, and is "vital" to the security of the United States.[2]

If a conflict breaks out in the Korean peninsula, the intervention of related super powers - US, USSR, China and Japan - will be indispensable. So, we can easily guess that a conflict in this area could lead to World War III. Therefore, the stabilization of the Korean Peninsula is very important to keep peace in the world as well as in the Western Pacific and Northeast Asian areas.

2. Major Power Balance around Korea

Northeast Asia ranks second only to central Europe as the most heavily-armed region of the globe. The Soviet union and China have established a military standoff along the Amour and Ussuri Rivers dividing Manchuria and eastern Siberia [Ref. 4: p. 1]. These days, nonhostile/nonaligined

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[2] This is derived from the Joient Statement between Korea and U.S(Nov 14, 1983), and between Korea and Japan(Sep 8, 1984).

China represents an important counter balance to the Soviets influence in the area [Ref. 6: p. 50].

The Republic of China, on the small island of Taiwan, has built a modern military establishment to defend itself against any attempt by Peking to liberate the only Chinese province outside its control [Ref. 4: p. 1].

Soviet military capabilities in the region continue to improve, providing greater opportunities for the Soviets to exert their influence. The Soviets have expanded their naval presence and strengthened their overall warfighting capabilities. Although the majority of Soviet land forces are positioned along the Sino-Soviet border, their presence greatly influences the military balances in Northeast Asia. Soviet deploys 52 divisions plus 1 corps, 1300 frontal aviation units, 318 ships and 410 naval aviation units in the region. With these military force, the Soviet actively intimidate ROK, US and allies in the region and support the aggressive polices of North Korea. The improvement of the Soviet and North Korea pose the greatest threat to ROK, US and allied interests in the region. In view of growing threats to regional security, close defense corporation and collective efforts are essential. [Ref. 6: pp. 5-49]

The Japanese are constitutionally restricted to maintaining only a defensive military force. The Japanese Self-Defense Forces, although well-equiped and well-trained, remain small in comparison with those of other countries. Table I represents a comparison of the major forces of the US and Japan. Japanese defense budgets are increasing slowly in recognition of the threat. Japan will continue to rely on the United States to counter any serious military threat. However, US bases in Japan continue to play a vital strategic role in providing US forces continuous access to the region. [Ref. 6: p. 49]

TABLE I

U.S. and Japanese Forces Compared

	Japan	U.S.
Population	119 mil.	235 mil.
Active Armed Forces	241,000	2,136,400
Army	156,000	780,000
Navy	42,000	569,000
Air Force	43,000	592,000
Reserves	41,000	955,300
Tank	950	11,996
Major Warships	48	187
Submarines	14	129
Helicopters	487	9,678
Combat Aircraft	373	5,586
1983 Defense Costs	$11.6 bil.	$205 bil.
Outlays per person	$97	$877
Share of government outlays	5.5%	25.8%
Share of total output	1.0%	6.4%

Source: U.S.News & World Report, November 1983

To keep the military balance in the region, the United States deploys 1 infantry divisions, 1 or 2 carrier battle groups, 10 tactical fighter squadrons, 1 marine amphibious force and 1 bomber wing, and provides a nuclear "umbrella". The US also maintains important bilateral security arrangements with ROK, Japan and the Republic of China.[3] [Ref. 6: p. 42]

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[3] The first formal security commitment of the United States was the mutual security treaty with the Philippines, which came into effect in 1952. This was followed by mutual security treaties with Japan(1952), The Republic of Korea(1954) and the Republic of China(1955).

3. Military Forces in North Korea and South Korea

Since the Korean Armistice of 1953, both North Korea and ROK have steadily rebuilt their armed forces with the assistance of their superpower patrons. This section describes the build-up in the North, and ROK and North Korea forces comparison.

a. Build-up in the North

The North Korean emphasis on the use of conventional military force to "reunify" the Korean peninsula stems from a communist party decision in the late 1960s [Ref. 7: p. 97]. Beginning in 1962 Kim Il-Sung put forward a refined doctrine of four main points generally referred to as the party's "four point military line." The new doctrine stressed the need for: training a cadre army in which each man was prepared to assume the responsibilities of the next higher rank-known as cadrification; adapting modern military techniques to the conditions of North Korea's many mountains and long coastlines; raising a nation in arms in which "the entire people, holding a weapon in one hand and a sickle in the other should reliably safeguard our socialist homeland"; and assuring the means of protracted struggle by a program to "build up zones of military strategic importance, develop the munitions industry, and create reserves of necessary materials." In October 1966, Kim called upon the North Korean Army to use flexibly both regular conventional and irregular guerrilla warfare tactics during possible conflict arising out of confrontations with South Korea. [Ref. 9: p. 226]

North Korea's most substantial force increases occurred after the North Korea enunciated a policy of peace and reconciliation with South Korea in 1969.

The impressive gains in the strength of the North Korean forces are evident from a ten-year and eight-year comparisons presented Table II It shows that the North Korean Army has doubled to 40 divisions and 25 special forces brigades. Its inventory of tube artillery similarly has undergone a two fold increase. Its tanks and armored personnel carriers have multiplied by a factor of three and ten respectively. [Ref. 7: p. 97]

TABLE II

Build-up Trends in North Korea

	1965	1975	1983
Divisions	20	27	40
Special Forces Brigades	12	20	25
Tanks	850	2,000	2,675
Armored Personnel Carriers	120	650	1,140
Artillery Tubes	2,850	4,000	6,000
Air Defense Guns	6,100	7,200	8,000
Combat Aircrafts	425	475	622

Source: The Posture of the Army and Department of the Army Budget Estimates for Fiscal Year 1985.

These days, the North Korea is producing some 300 tracked vehicles per year, about equally divided between tanks, APCs, and self-propelled artillery [Ref. 7: p. 94]. The North Korea deploys 3 tank corps (each corps has three divisions) in the western end of the DMZ, according to Japanese Sankey Newspaper report(September 23, 84). Enough armor now is available to equip several armored divisions, a few independent armored brigades, as well as some mechanized and motor divisions.[4] Tube artillery has been in production since the late 1960s and includes the full complement of Soviet designs. It is evident from Table II that the artillery holdings of North Korean forces are substantial. [Ref. 10: pp. 64-65]

Assuming that most of the artillery will be located in the western end of the DMZ. We note that North Korean ground forces have sufficient powers to attempt four simultaneous breakthrough operations in the first echelon. Each point of attack can be allocated 500 artillery pieces, 150 tanks and assault guns, and a number of infantry regiments. For breakthrough operations the relevant norms[5] are the density (number per kilometer of front in the breakthrough sector) of forces deployed. These are summarized in Table III for the Soviets in WWII, their current doctrine, and for the North Koreans today. [Ref. 7: p. 98]

According to General Don Starry, the North Koreans would use three echelons of forces in the offensive. The initial assault would comprise an artillery barrage followed by a "massive blow of infantry and tanks" - to quote the Soviets - with breakthroughs exploited by two follow-on echelons made up of tank and mechanized infantry divisions. The breakthrough attempts would be assisted by combat engineers and by elite infantry called ranger/commandos in North Korea. Kim Il-Sung has dramatically increased the size of these forces so that they now number about 100,000. Of these forces, about 70% are thought to be

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[4] According to the Military Balance(1983-1984), the North Korea has 2 armored divisions, 5 armored brigades and 3 motor infantry divisions [Ref. 11: p. 93].

[5] From "battles" against German, the Soviets developed a set of rules - they call them "norms" - derived from considerable data, as well as the spilling of a lot of blood. These data are relevant to the present time, and in particular to the Korean peninsula.

TABLE III

Force Densities in Breakthrough Sectors

(number per kilometer)

	USSR		North Korea
Unit Type	WWII	Current Doctrine	Assumed Forward
Regiments or Brigade	1-2	0.5-1	1
Artillery	40-120	75-100	500
Tanks and Assault Guns	35-50	50-60	>100

(number per kilometer)

Source: Armed Forces Journal International, September 1984

assigned to the ground units, with their primary mission probably the task of assisting in breaking through the formidable ROK defenses. The function of the tunnels under the DMZ now becomes clear: the survivable insertion beyond the DMZ of ranger commandos into the ROK defense in depth.

Ranger/commandos assigned to the North Korean Navy will go after ROK facilities on or near the coasts. They will arrive in fast boats escorted by covering crafts. Other fast boats will provide fire-support at the landing sites simultaneously.

The Ranger commandos assigned to the Air Force will be lifted via AN-2 transport. North Korea has purchased and operates about 250 AN-2 aircraft, each capable of carrying about 10 fully equipped paratroops. These propeller-driven biplanes are suitable for low-level, terrain-following flight, and are a cheap means of inserting ranger/commandos at communication sites, ground control intercept facilities and ROK and US airbases. North Korea's ranger/commandos probably will be equipped with small arms and satchel charges to destroy ROK and US airplanes. [Ref. 7: p. 103]

Moreover, they can be expected to target all senior political and military officals, US and ROK, as was attempted in the "Blue House raid" in January, 1968 [Ref. 10: p. 65]. Apparently, the North Korea has built up an Army that is now the size of the US Army and has the third largest Army in the communist world, exceeded only by China and the Soviet Union. Now, the North Korea establishes the ability to wage a multi-dimensional war with as little as 12 hours warning [Ref. 7: pp. 94-104].

b. South and North Korea Military Forces Comparison

The impact of the North Korean military build-up on the regional balance[6] can be seen in Table IV. Several years ago, most security analysts took comfort from the fact that the ROK Army was much larger than its Northern counterpart. Today, the situation is reversed. The Army of the North Korea numbers more than 700,000 men compared to 540,000 men in the ROK Army. When suppression systems are combined, we see that the north enjoys almost a 3:1 advantage in artillery. But the numbers do not disclose the longer range and higher firing rates of the northern-produced equipment, which follow Soviet designs. The North also enjoys a qualitative and substantial advantage in tanks. North Korea has advanced from T-54/55 tanks to T-62s, while ROK forces still have about 300 of the outdated

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[6] Military balance is the comparison of the intensity and duration of war that can be waged by the operational weapons (i.e., military capability) of one nation versus that of another nation [Ref. 12: p. 31].

TABLE IV

ROK and North Korea Force Comparisons: 1983

	North Korea	South Korea
Personnel		
Army	700,000	540,000
Navy	33,500	49,000
Air Force	51,000	33,000
Divisions	40	25
Special Forces Brigades	25	7
Tanks	2,675	1,000
Armored Personnel Carriers	1,140	850
Artillery Tubes	6,000	2,100
Mortars	10,500	7,410
Multiple Rocket Launchers	2,850	0
Air Defense Guns	8,000	300
Combat Aircraft	622	380
Combat Ships	512	102
Submarines	21	0

Sources: The Posture of the Army and Department of the Army Budget Estimates for FY 1985 and the Military Balance (1983-1984)

-47 tanks in services[7] [Ref. 7: p. 97]. One way to ummarize the military balance is to form ratios of the mportant categories of equipment for the years 1970 and 980.

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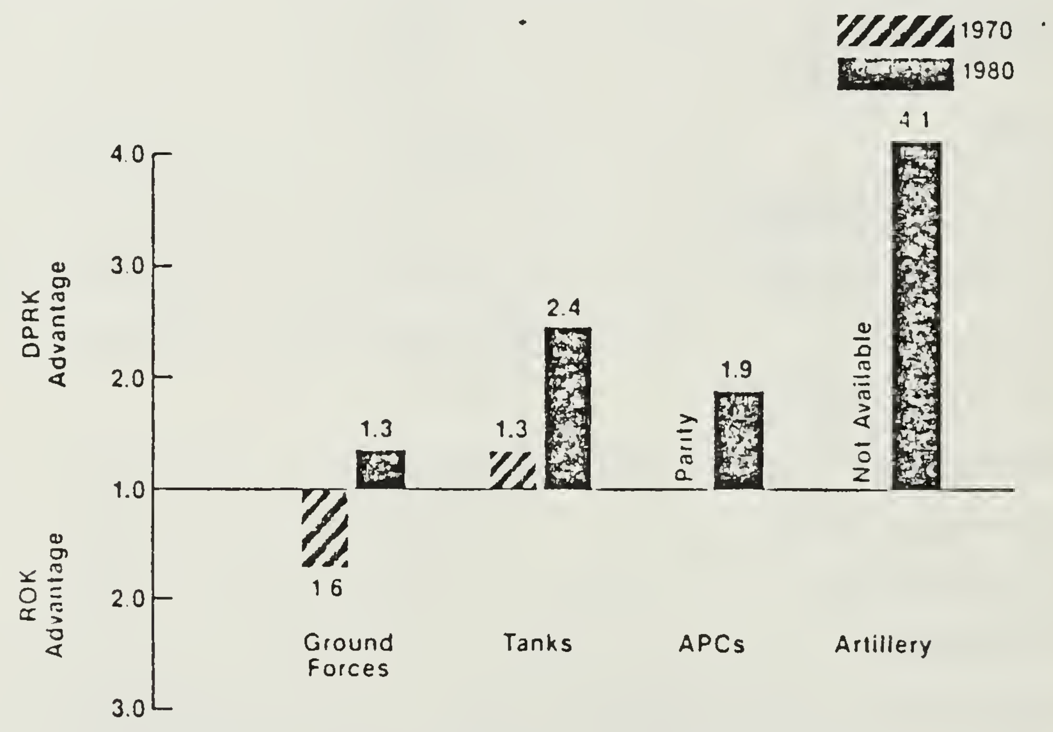
[7] According to the Military Balance(1983-1984), the North orea has 300 T-34, 2200 T-34/-55/-62, 175 Type-59 MBT, 100 T-76 and 50 type-62, while the ROK has 1200 M-47/-48 Ref. 11: pp. 93-94].

The ratios for important military force elements are given in figure 2.1. North Korea has turned everything in his favor in just 10 years. Figure 2.1 shows the North Korean advantage in force ratios; 2.5:1 in tanks, 4:1 in artillery and heavy mortars, and a little more than 1:1 in personnel. [Ref. 7: pp. 97-98]



Source: Armed Forces Journal International(Sept 1984)

Figure 2.1 Force Ratios for Ground Forces and Equipment.

The North Korean Navy(NKN) is numerically superior to ROK Navy(ROKN) and is an offensive force, while the ROKN is still a coastal defense force. The NKN can threaten surface ships, combatant and merchant, with some 21 diesel submarines. It is able to mine the waters in and around several important ROK ports, e.g., Pusan and Pohang. They can also insert the naval part of the ranger/commando troops into the south in escorted amphibious craft [Ref. 7: p. 104]. The ROKN has no submarines for operation. Even if it had them, the naval balance would not change greatly since North Korea depends for less than the South on sealanes for trade or resupply of combat material. Submarines would, however, be useful for patrolling coastal waters against North Korean submarines. In all, North Korea has more than 500 fighting ships[8] with 33,500 men, compared with about 100 fighting ships with 29,000, which is excluding marine members, for the ROKN. [Ref. 10: p. 66]

The Air Forces of both sides still hold equipment dating to the 1950 War: nearly 80 F-86Fs are still flying in the ROK Air Force(ROKAF) and about 300 MIG-15/17s are operational in the North. The ROKAF also fields about 60 F-4s and 250 F-5s. A co-production agreement has been established with the United States for the ROKAF to modernize its F-5 inventory to F-5Es. The modern aircraft of North Korea consist of roughly 100 MIG-21s. The North Koreans also have a Chinese version of the MIG-19(about 150). Ground attack aircraft are made up of 20 Su-7s and 60 Il-28s. There are 60 helicopters in the inventory with early Soviet MI-4 and MI-8 models predominating. In all, the balance in airpower shows about 600 combat aircraft with 51,000 men in the North, as contrasted with roughly 400 ROK aircraft and 33,000 men.[9] [Ref. 10: p. 66]

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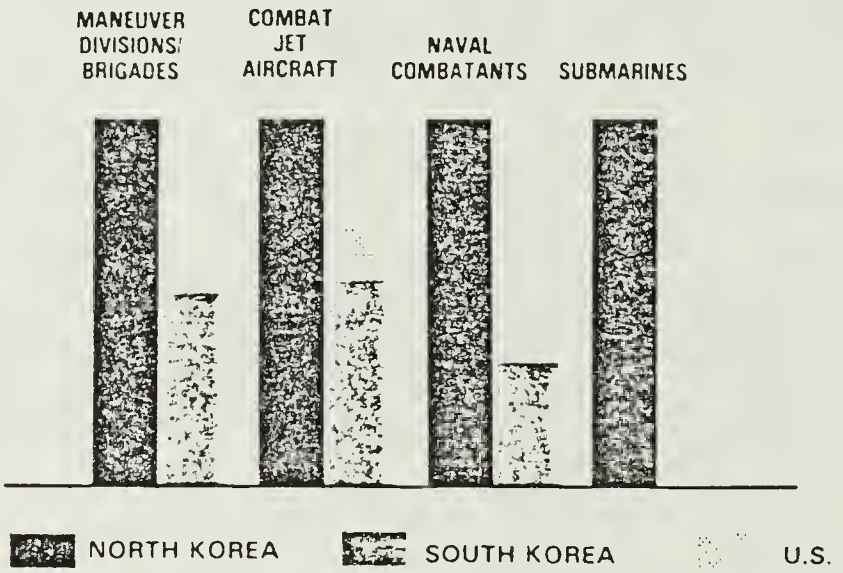
[8] According to the Military Balance(1983-1984), the North Korea has 18 SOV FAC(M), 32 large patrol craft, 151 FAC(G), 182 FAC(T), 30 coastal patrol craft,9 LCU, 15 LCM and 75 Nampo landing craft while the South Korea has 11 US destroyers, 8 frigates, 3 US Auk Corvettes, 11 FAC(M), 8 US Cape Large Patrol Craft, 28 coastal patrol craft, 8 MSC-268/-294 coastal minesweepers, 1 Mine Sweeping boat and 24 US landing ships, and on order: 1 sub, 7 corvettes, 20 FAC(M), 75 Harpoon SSM [Ref. 11: pp. 93-94].

[9] According to the Military Balance, the North Korea has 740 combat aircraft: 70 IL-28, 20 SU-7, 290 MIG-15/-17, 100 MIG-19, 100 MIG-19/Q-5 and 160 MIG-21 while the South Korea has 450 combat aircraft: 250 F-5A/B/E/F, 70 F-86F, 6 A-10, 70 F-4D/E, 24 OV-10G, 10 RF-5A and 20 S-2A/F [Ref. 11: p. 94].

January 1984, the Joint of Chiefs of Staff(JCS) analyzed the military power balance on the Korean peninsula. Main points are as follows:

> The North Koreans have vowed to reunite the Korean peninsula under one government. The buildup of their armed forces consumes 20 percent of North Korea's annual GNP and continues at a rate beyond that required for legitimate defensive purposes. The North Koreans deploy about half their combat forces near the border of the ROK. They stress mobility, firepower, and shock action and maintain the capability to launch an offensive on short notice. The ROK continues its efforts to achieve an independent capability to resist aggression but still US support to deter or counter a North Korean attack. The United States forward deploys an Army division plus Air and Naval forces in Korea. [Ref. 6: p. 49]

In all, Figure 2.2 provides a comparison of major forces on the Korean peninsula.



Source: The Military Posture of JCS for FY 1985

Figure 2.2 Comparison of US/ROK and North Korean Forces.

So far, the conventional military forces between ROK and North Korea have been compared. These days economic wer is also recognized as a very important potential ctor which improves military force [Ref. 13: p. 11]. ble V shows the comparison of economic size and military ending of both Koreas.

TABLE V

Indicator of Economic Size and Military Spending, 1982

Indicator	North Korea	South Korea
Population (millions)	18.7 (19)	40.7 (42)
Armed Forces per 1,000 population	38.0	14.7
GNP (millions of US dollars)	16200	69539
Per Capita Income (US dollars)	817 (>1000)	1611 (2000)
Military Spending (millions of dollars)	3500	4783
Military Spending as % of GNP	21.6 (24)	6.9 (6)

Source: U.S. Arms Control and Disarmament Agency, World Military Expenditures and Arms Transfers 1972-1982.
( ) represents the estimate of 1984 by source of [Ref. 7: pp. 94-97].

The South's consistently higher economic growth ates have helped it achieve a gross national product in 982 about over four times that of the North, and the uth's economic edge is likely to become greater in the ture[10] [Ref. 14: p. 27]. With a population of 19 million people and a per capita income of less than $1000, North Korea spends more money per capita on defense than any other country in the world except Israel [Ref. 7: p. 94]. The ROK spends 6% of its GNP on defense with a population of 42 million people while the North Korea lavishes about 24%. However, North Korean industry is handicapped by old machinery, and the heavy burden of defense seriously limits the resources available to keep the economic moving [Ref. 15: p. 93]. The ROK's per capita income is more than $2000 and rising, though already more than three times that in the North [Ref. 7: p. 97]. Given the enormous disparity between the two economies, the fact that only 6% of the South's GNP, compared with 24% in the North, is devoted to military-related expenditure is not as alarming as it might appear at first glance. Time too, will take its toll on the relative strength of the North's build-up, and the North's slower economic growth makes holding on to its military advantages more difficult. As a result, South will move ahead of the North at an increasing tempo, and this is shifting the balance of power on the peninsula. [Ref. 14: p. 27]

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[10] According to the Hankook-Ilbo(Aug 31,84), the South orea has a GNP nearly five times that of North Korea(about billion, compared with about 14 billion).

In view of these points, President Chun Doo Hwan announced as follows:[11]

> Military balance will be established when we invest 6 percent of GNP in military expenditure, assuming that we can make economic growth continuously for 4 or 5 years without conflict on the Korean peninsula.

Figure 2.3 shows this possiblity. The International Institute for Strategic Studies(IISS) estimated that the military imbalance can be overcome by the end of the 1980's. This scenario has prompted some observers to predict a desperate move by North to make the most of what advantages it now has, before they slip away.

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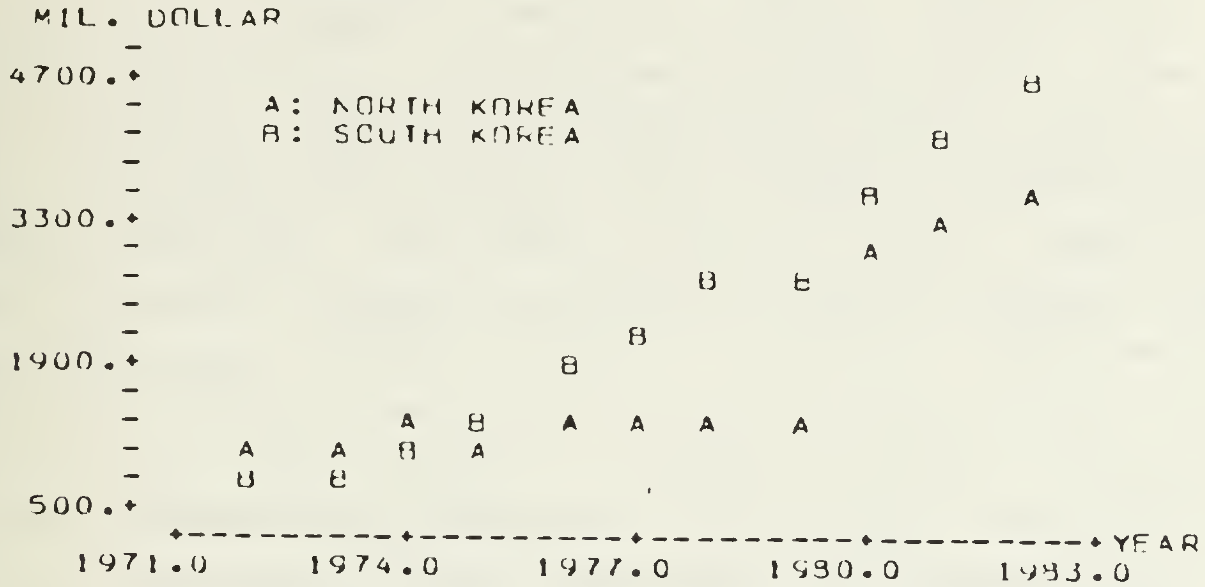
[11] This source is derived from the presss interview of President Chun on August 21, 1984.



Source: World Military Expenditures
and Arms Transfers(1972-1982)

Figure 2.3 Military Spending in North and South Korea.

In conclusion, North Korea retains an edge over the South only in military might. And this comparison, is shifting in the South's favor. [Ref. 15: p. 93]

B. THE RELATIONSHIP BETWEEN ROK AND US

1. Political and Economical Relationship

The last 100 years, since the establishment of US - ROK relations in 1882, were marked with ups and downs in the bilateral relationship, but the friendship and the sense of alliance formed a strong basis for their ties.

In retrospect, the United States, a pacific power and leader of the free world, played a decisive role in liberating Korea in 1945 and safeguarding the fate of the Republic of Korea during a devastating war on the peninsula in 1950-53. Korea, in return, extended a helping hand when America needed one in Vietnam.

Otherwise, smooth relations between the two countries were tangled, though momentarily, by the human rights issue. The origin of these issues can largely be attributed to the different cultural and political backgrounds of the two peoples. True to the proverb that the ground gets harder after it rains, the Korean-American relationship today can hardly be better. Korean President Chun Doo Hwan was the first foreign head of countries invited to visit Washington by President Reagan in January 1981, and the US troop withdrawal plan has been scrapped. [Ref. 16: P. 18]

In November 1983, President Reagan visited Seoul and then reaffirmed the support for the Republic of Korea. President Reagan said as follows in a speech to the National Assembly, South Korea's legislature:

> You are not alone, people of Korea. America is your friend and we are with you.

As ROK joins the world community at an increasing pace particularly since the economically prominent 1970s and the increasing international recognition of Korea,[12] it now seems to be concerning Americans more and more as they find it necessary to build a true partnership.

In 1982, the bilateral trade totaled over $11 billion. The ROK becomes one of the US most important trading partners and the fifth largest market for the US agricultural product, and also the United States is the

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[12] Seoul in Korea is to be the site of the Asian Games in 1986 and the Olympics in 1988.

Republic of Korea's largest trading partner in exports as well as imports.[13]

Trade has been brisk, and observers say the expanding trade should be furthered to increase the mutual relationship which they say is an important factor for strengthening ties between the two peoples.

Today, the political stability, economic development and international recognition of ROK help Korea to keep the closer relationship with US, and also the increase of trade has a positive effect on the security relationship between two countries.

2. Security Relationship

According to the text of Chun-Reagan Joint statement (Nov, 1983), "the security of the Republic of Korea is pivotal to the peace and stability of the Northeast Asia and in turn vital to the security of the United States."

Now, the two countries have excellent security relationships. However, the security relationships have been marked with ups and downs according to US defense policy.

The security relationship stemmed from the US military landing at Inchon in South Korea in September 1945. Until May 1948, The South Korea was under control of US military. The three-year occupation period was characterized by uncertainty and confusion, stemming largely from the absence of a clearly formulated United States policy for Korea and intensification of the conflict between the United States and Soviet Union. Moreover, the Soviet Union consolidated its power in North Korea, as the Nationalist government of Chiang Kai-Shek began to falter in China, US strategists began to question the long-run defensibility of South Korea. By 1947 it began to appear that South Korea would become the only area of the Northeast Asian continent not under communist control. [Ref. 8: p. 22]

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[13] This source is derived from the text of Chun-Reagan Joint Statement, which was announced on November 14, 1983.

Early in September, the US Policy Planning Staff concluded that Korea's minor significance for American national security seemed to justify disengagement. The JCS also responded categorically that "from the standpoint of military security, the United States has little strategic interest in maintaining present troops and bases in Korea..."

On June 7, 1949, President Truman indicated as follows:

> The Korean Republic, by demonstrating the success and tenacity of democracy in resisting communism, will stand as a beacon to the people of Northern Asia in resisting the communist forces which have overrun them. [Ref. 17: p. 193]

Finally, on June 29, 1949, the United States withdrew the last of its combat forces from Korea, thus ending almost four-years of military occupation.

Then, on January 12 1950, Secretary of State Dean Acheson made his famous speech excluding Korea and Formosa from the American defense line in the Far East. That perimeter, said Acheson:

> ... runs along the Aleutians to Japan and then goes to the Rhykus (and) from the Ryukyus to the Philippine Islands... So far as the military security of other areas in the Pacific is concerned, it must be clear that no person can guarantee these areas against military attack. But it must also be clear that such a guarantee is hardly sensible or necessary within the realm of practical relationship. [Ref. 18: pp. 36-37]

Less than six month later, a well-equipped North Korean Army launched a massive assault across the 38th parallel in pursuit of forcible reunification. President Truman was shocked. As he has since written:

> There was now no doubt! The Republic of Korea needed help at once if it was not to be overrun. More seriously, a Communist success in Korea would put Red troops and plans within easy striking distance of Japan, and Okinawa and Formosa would be open to attack from two sides. [Ref. 18: p. 53]

The United States and other countries,[14] which are under the the jurisdiction of the United Nations, intervened to halt and push back this attack [Ref. 5: p. 68].

On July 14, 1950, President Ree formally placed all ROK forces under UN command. This was by letter, and was known as Taejon Agreement. After this Taejon Agreement, the ROK took part in the Korean War as one of the United Nations. In 1978, the operational command of the Armed Forces was transfered from the United Nations Command in Korea (headed by a United States general officer) to a newly established joint US-ROK command structure, the Combined Forces Command (CFC). After the Korean War, the ROK-US Mutual Defense Treaty was made in November 1954 and maintains until now.

On April 17 1968, President Park met President Johnson in Honolulu. This meeting was aimed at assuring the South Korean leader that his country's interests would not be compromised by a Vietnamese peace agreement and at reaffirming the American military commitment to South Korea. Mr. Johnson, in accordance with the terms of the ROK-US Mutual Defense Treaty, reaffirmed the US readiness and determination to repel armed attacks against South Korea. [Ref. 19: p. 153]

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[14] Other countries represent Australia, Belgium, Canada, Colombia, Ethiopia, France, Greece, Luxembourg, Netherlands, New Zeland, philippines, Thailand, Turkey, Union of South Africa, and United Kingdom.

After one month, ROK-US military leaders' meeting was held in Washington in order to improve the ROK military forces. This meeting was improved to the annual meeting, which was the Security Consultative Meeting(SCM). The 16th SCM was held in Seoul on 9 May, 1984. The SCM has dedicated in improving the ROK's military capability and the ROK's support for US Armed forces in Korea.

In 1969, the Nixon Doctrine was first enunciated publicly at background press briefing in Guam. Nixon Doctrine included three main parts: first, a posture of gradual US military force reduction from its forward defense positions in the Asia-Pacific region: second, an insistence that the smaller and medium-sized powers of Asia must provide for their main defense needs out of their own resources - although US would provide some material help in deserving cases - and third, an emphatic assurance that vital American commitments and especially such treaty commitments, as those involved with Korea, could be relied upon [Ref. 20: p. 37]. ROK leaders were very surprised at the Nixon Doctrine and felt keenly the necessity of self-reliance. US leaders began to negotiate to make sure that in withdrawing some of US forces and they would continue to provide the necessary military assistance to supplement our own strong defense establishment [Ref. 21: p. 18]. In April 1971, an infantry division was pulled out during the Nixon Administration. In 1975, the US free military aids terminated. Meanwhile, the North Korea had improved its military force with the four point military line since 1962. In the beginning 1970s, the North Korea announced the completion of preparation for war against ROK, and provoked incidents frequently. In view of these environments, ROK began to build up its Defense Industry.

In March 1977, President Carter announced his intention of removing the remaining US ground combat forces, the US Army Second Division. There was disagreement over whether the withdrawal of the Second division was a prudent risk, as the Carter administration maintained, or whether it would shift the military balance and "lead to war," a position taken by Major General John K. Singlaub, former chief of staff of US 8th Army in Korea [Ref. 4: p. 57]. Moreover, Dr. Lefever insisted as follows:

> The abrupt and undebated decision to withdraw American ground forces from Korea will have a negative impact upon the US position in Asia and more generally upon America's capacity and determination to stand behind its allies in a crisis [Ref. 3: p. 28].

However, Stuart and Joseph concluded that some US forces were in excess of clearly identifiable military requirement in Northeast Asia. Further, they recommended significant reduction in US ground forces in Japan and Korea [Ref. 4: p. 87]. The total withdrawal plan was delayed and then was rescinded in 1981 by the Reagan administration and military realities in Northeast Asia.

The presence of American soldiers in Korea guarantees the security of the Republic of Korea, frustrating the unchanging Communist plot to invade the South at an opportune time. Major exercises, such as TEAM SPRIT, also demonstrate allied cooperation and US reinforcement potential.

From a broader aspect, however, the US military presence in Korea has an international implication. The balance of power maintained on the peninsula with participation of the American forces contributes to the maintenance of peace in Northeast Asia and the world as a whole. [Ref. 16: pp. 18-19]

C. MILITARY PROBLEMS

In carrying out our policies toward peace on the Korean peninsula, the Republic of Korea faces problems that are, at least in part, military: military imbalance between North and South Korea, uncertainty of US defense policy, geography and logistics problems.

1. Military Imbalance between North and South Korea

The North Korea has made enormous improvements in its armed forces during the past 30 years, enough to be of real concern to the ROK. These improvement coupled with Kim Il-sung's unpredictability, make for a serious problem. The South Korea is really worrying about Kim Il-sung's "erraticism and the North Korean's aggressive Attitude." [Ref. 7: p. 94]

Today, North Korea is superior to South Korea in terms of the quantity of weapons, but the South Korea tries to overcome the imbalance by reaching to better quality. Moreover, the enormous disparity between the two economies can help the South Korea to gain the military superiority in the future. Therefore we can guess that North Korea will make the most of what advantages it now has, before they slip way.

Neither China nor the Soviet Union, both sponsors of the North Korea, want a major conflict on the peninsula, but no one is certain that either China or the Soviet Union could restrain North korea if Kim Il-sung got the bit in his teeth and decided to "go for it" [Ref. 7: p. 94]. Finally, either the Soviet Union or China will support the North Korea. Therefore, the support of the United States is essential to defense of ROK national survival.

2. Uncertainty of US Defense Policy

If North Korea invaded South Korea tomorrow, would the US risk getting involved in a large-scale war to come to the South's defense? This question is a real concern to the Korean people. In a view of both points, that is the gut question underlying the at-times-uneasy relationship between Washington and Seoul.

In November 1983, President Reagan spent just three days in Korea answering it with a resounding "yes." However, many of the actions taken by the United States in Northeast Asia are also aspects of its global policies. Despite the importance of Korea's geographical location, Korea has been recognized less important to the United States than either Japan or China [Ref. 4: pp. 3-5]. This basic concept has negative effect on the evaluation of Korea's strategic worth. Moreover, it's strategic worth has been changed with ups and downs by US political situations.

In January 1975, President Carter used the Korean affair as the major foreign policy for his election issue. Not until 1975 was any US policy toward Korea influenced by public opinion greatly.

In March 84, Americans' attitudes toward Korea were expressed at the Asian study conference by William Watt.[15] He used the Gallup polls to research American's attitudes. His main points are as follows:

1. One of the questionnaires is the degree of importance of each countries for US national interests. The result is represented in Table VI. Table VI shows that the degree of importance of Korea is 15th and that 66% of US leaders and 43% of general civilians recognized the importance of Korea toward US. Despite a relatively close economic relationship, Korea is located at low degree. We note that there is big gap between leaders and general civilians.

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[15] The contents of this report are derived from the Hankook Il-bo: March 29, 1984.

2. Another questionnaire is as follow. If North Korea invaded South Korea, would US support South Korea? The result is represented in Table VII. Table VII shows that most of Americans don't want US military intervention in a case of conflict on the Korean peninsula. From 1978 to 1982, the disagreement side was over 50%, but the disagreement side dropped under 50% in 1983. Moreover, the agreement side increased a few points in 1983. The peak of agreement was in 1980. Someone explained the peak of agreement as follow. When President Carter announced his intention of removing the remaining US ground combat forces, a lot of Americans favored the withdrawal plan. After visiting Korea in 1979, President Carter changed his mind. At that time, most of American supported the change of US policy. So, the peak of agreement resulted from support for the change of US policy toward Korea. However, we note that agreement side is still under 40%.

TABLE VI

The Degree of Importance for US

Ranking	Country	Leaders	Civilians
1	Mexico	98	74
2	West Germany	98	76
3	Japan	97	82
4	United Kingdom	97	80
5	Canada	95	82
6	Saudi Arabia	93	77
7	Israel	92	75
8	Egypt	90	66
9	China	87	64
10	France	84	58
11	Brazil	80	45
12	Italy	79	35
13	Lebanon	74	55
14	Jordan	67	41
15	Korea	66	43
16	Iran	60	51

unit: %

Assuming that US decisive decision toward Korea would be influenced by political change and public opinion, the US support plan for Korea would be uncertain if there is a conflict on the Korean peninsula.

TABLE VII

Agreement for US Intervention for Korea

	1978	1979	1980	1982	1983
Agreement	32	32	43	33	36
Disagreement	52	56	51	51	47
No comment	16	12	11	16	17

unit: %

3. Geography

A conflict in Korea would be decided primarily by the effectiveness of the opposing ground forces.[16] The attractive naval target for North Korea is the port of Pusan, through which most of Korea's materiel would be shipped during wartime. The ROK Navy and rear-area security forces have the limited resources to prevent large-scale North Korean amphibious attacks and infiltration. The South's anti-submarine capabilities are limited, however, and the North's 21 submarines could affect efforts to resupply the South with war material [Ref. 4: pp. 80-81]. The North, with overland links to both China and the Soviet Union, is not dependent on shipping at all.

Because the ridges of mountains in Korean peninsula generally run north-south, both attacker and defender are forced to operate in corridors. Should the attacking forces be concentrated where defensive forces are weak, timely reinforcement by the defender would be difficult. The Taebaek mountain range is a particularly imposing barrier, isolating ROK forces on the east coast from the bulk of the forces in the west. Terrain also limits the usefulness of simple communications equipment, since communication across mountain ranges demands sophisticated equipment.

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[16] Most of contents of this subsection come directly from [Ref. 4: pp. 57-59].

Equally significant in its effect on the South's defense strategy is the location of Seoul, only forty kilometers from the DMZ. The North Korean capital, Pyongyang, on the other hand, is about 150 kilometers from the DMZ. Seoul is the South's capital and its economic and political heart with a population of nearly 10 million, more than 20 percent of the total population of South Korea [Ref. 14: p. 26]. Once driven out of Seoul, ROK forces would find it difficult to regroup and to retake the city.

In a blitzkrieg invasion of Seoul, North Korean armor would be forced to use the same invasion corridors it used in the Korean War: the two corridors that merge into one at Uijongbu, sixteen kilometers north of Seoul; and a corridor further west-near Panmunjom and passing through Munsan. At key choke points along these corridors are manned fortifications and concrete impediments that can be dropped onto the roadway by blowing up their supports. Invading tanks would be particularly vulnerable at these points, since they would be exposed to fire from defenders who are well dug in and therefore difficult to suppress with artillery fire. While the roadblocks would not prevent an armored advance, they would slow it, making it vulnerable to air or ground fire.

In summary, the limitations imposed by terrain combined with the South's anti-armor weapons are serious obstacles to a blitzkrieg invasion from the North. The experience of 1950, when North Korean tanks drove down the peninsula unopposed, is not likely to be repeated. Still, problems remain in the ROK's defenses.

One problem inherent in the South's adoption of a defensive posture is that the North can choose the place of attack and the South has limited capability to reinforce it.

Troops and supplies have to moved by truck, and driving east or west below the DMZ is tortuous. The south's helicopter airlift capacity is insufficient to provide meaningful resupply or reinforcement. Reinforcement of defenses on the east coast would be most difficult, although since the area is thinly populated and has few military targets, ROK forces could trade space for time; no such luxury is available in the invasion corridors leading to Seoul. [Ref. 4: pp. 57-59]

4. Logistics

Through the Korean War (1950-1953) and participation in the Vietnam War (1968-1973), we obtained experience to be able to wage modern war. Unfortunately, we obtained less experience in the logistics field, because we waged the Korean War under support of US and other U.N. countries and participated in the Vietnam War under support of US. Little experience in logistics in both wars has resulted in neglecting the importance of logistics.

Considerable effort and study have been devoted toward the development of credible strategic and tactical doctrine and training systems. Various strategies are continually under review to find better methods of projecting military capability under coordination with US. Throughout this process, one central question has usually been avoided and delayed: What about military logistics? Logistics has been relegated to a category of secondary importance. The idea that "logistics supports the weapon" or in fact that logistics provides "support" still prevails.

Moreover, when South Korea rebuilt its Armed Forces following the Korean War, it emphasized combat units rather than support units. While this has little effect during the opening days of war, it affects the tide of battle as the staying power of South Korean forces is weakened by thin logistic support. [Ref. 4: p. 80]

A forward defense, in which the defender cannot afford to yield a great deal of territory, demands heavy artillery and mortar bombardment and close air support. Moreover, a heavy barrage of indirect fire spends a lot of munitions in the first days of a conflict, and ROK conventional munitions in place may be inadequate. Also, the logistics network for moving supplies from the port of Pusan or airfields in the South to the combat area is thin, and since they would come primarily from the United States, would require weeks of transit time.

The worst is as follows. The US military exercise, called "Pressure Point 84," showed that the Army would begin running out of key munitions and other items in the first month of a war in South Korea and could be forced to accept a stalemate because of shortages of critical supplies.[17] Therefore, adequate stocks of conventional ammunition in the theater would go a long way to enhancing South Korea'a defense capability.

To increase these stocks, the United States could assist the South in improving its munitions industry. The Republic of Korea began to build the defense industry since 1975, but it faces some technical problems.

Despite of continuous economic growth, we are a short of fund to improve the military capability. We spend more on consumable items such as food, clothes, facilities and pay rather than on military hardware. Moreover, the ROK National Assembly reduced FY 85 military expenditures to 5.5% of GNP.

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[17] This source is derived from Washington Post newspapers:August 3, 1984.

While strategies and tactics are quickly adopted to changing situations and objectives, the logistics system always need a large and complex process requiring complete and careful management to make sufficient changes in objectives or results. Today, knowledgeable logistics leadership, guidance, and policy are needed to create a single logistics operation focused on attaining necessary military capability in ROK Forces. [Ref. 5: pp. 85-86]

D. ALTERNATIVES TO SOLVE PROBLEMS

Our final goal on the peninsula is to keep peace first, and then to establish "reunification" peacefully. First of all, to establish this goal, we must never give Kim Il-sung the opportunity to make a wrong decision such as "go for it."

Our basic strategy is to improve our self-reliance under close coordination with the United States. Our hope is to gain the balanced military as soon as possible. We believe that the military balance can guarantee peace on the peninsula. Relatively, we have more person resources and economic size than North Korea. These factors can give us a great military potential power. However, now North Korea's military force is superior to that of South Korea. So, the pressing need is to establish military balance on the Korean peninsula.

We have some problems such as big military imbalance, uncertainty of US defense policy, geography and logistics. How do we overcome these problems and then reach military balance? Possible alternatives are enormous, but the most challenge is to improve military logistics. The reason is that one of the weakness in ROK's military is logistics.

These days, military environments have been changing rapidly everywhere in the world. Since world war II, the importance of logistics has been stresssed at all level of military activity.

For this importance of logistics, Fred Gluck stated that:

> The importance of strategies and tactics notwithstanding, 'modern' military logistics is the basis of military power (the level and duration of war that can be waged by combat forces). Therefore, the effective and efficient operation of "modern military logistics" is critical to the safety and survival of US nation. "Modern military logistics" must provide the assurance that concept, structure, focus and management of military logistics are present and effectively aligned to provide for the need of today's military forces in general and its combat forces in particular. [Ref. 22: p. 14]

Modern military logistics is also critical to defend our nation. If we fail to understand modern military logistics, many problems will occur. Possible problems are as follows:

1. We can't make the best of defense budget efficiently and effectively.
2. We can't establish an effective and efficient military logistics operation.
3. We can't develop the logistics doctrine.
4. We can't measure productivity and effectiveness, or perform valid trade-off analysis anywhere within the total logistics environment.
5. We can't measure or compute capabilities to wage war accurately.
6. We can't determine the extent of war that can be waged by our own forces.

To solve logistics problems and improve our own forces, we'd like to suggest as follows. First is to understand modern military logistics fully and to set the concept of modern military logistics which indicates the direction of military logistics. Second is to establish the Integrated Logistics Supports with effective and efficient manner. Third is to establish the rational acquisition process in terms of Life-Cycle Cost model.

III. THE SETTING OF MODERN MILITARY LOGISTICS CONCEPT

To set the Modern Military Logistics Concept for ROK military, it will be necessary to study the evolution of logistics in world military history. After that, we describe a proper concept of modern military logistics for ROK's military improvement.

A. THE EVOLUTION OF THE CONCEPT OF MILITARY LOGISTICS

1. The Beginning Phase of Military Logistics

Logistics activities were performed before the birth of Christ. Demand forecasting, site selection, order processing, inventory management, and packaging were employed some 4000 years ago to save Egypt from the ravage of seven years of famine. [Ref. 23: p. 10]

A first record in related to logistics did appear in a book written in about B.C. 500 by Sun Tzu Wu.[18] This book was called "the art of war", the oldest military treatise in the world. He stated as:

> The art of war is governed by five constant factors. These are the Moral Law, Heaven, Earth, the Commander, and Method and discipline. By method and discipline are to be understood the marshalling of the army in its proper subdivisions, the gradation of rank among the officers, the maintenance of roads by which supplies may lead army, and the control of military expenditure. [Ref. 24: p. 3]

We can also find the root of word logistics in western history. Graham w. Rider investigated the origin of the word "logistics" in his article.[19]

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[18] Sun Tzu Wu was a native of the Ch'i State in China.

[19] Most of contents of the rest of this subsection come

In the beginning there were two words, "logistikos" and "logisticus". The first is Greek, the second, Latin, and they both had same meaning - calculation or reasoning in a mathematical sense. The first meaning , to reason mathematically, has remained constant for centuries. The second meaning of logistics back to some obscure early usage of the latin root, "log-". Latham states that "logluguea", a noun meaning lodge or hut, appeared in records dated 1350; and "logio", a verb meaning lodge or dwell, appeared in 1380. He attributes the French verb, loger, meaning "to lodge" to this Latin antecedent. It leads directly to the second meaning of logistics. [Ref. 25: pp. 280-281]

As civilized societies grew out of the medieval age and began to acquire sophistication, so too did the nature of the warfare in which these societies engaged. Armies grew in size, and the problems of administering them also grew. Sometime near the year 1670 an adviser to the French King, Louis XIV, proposed a solution for these military problems in the form of a new staff structure for the army. One of the newly created positions was that of Marechal General des Logis, whose title came from the verb loger. This officer was responsible for planning marches, selecting camps, and regulating transportation and supply. This instance appears as the first application of the new meaning of logistics and the first organizational usage of logistics as we recognize it today. Although we could go into greater detail in investigating the origins of the logistics profession, it seems enough to say that someone has always had to furnish supplies and transportation for military forces. That office has had a number of titles down through history, but it was the French who gave us the modern term logistics.

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directly from [Ref. 26].

Jomini first used the term "la logistique" which has been translated to English as logistics. He can be called the "father" of military logistics. He drew upon his experiences in a number of wars, principally from those campaigns when he was a staff officer for Napoleon, to write the following.

> If it be acknowledged that the ancient logistics was only a science of details for regulating everything material in regard to marches; if it be asserted that he functions of the staff embrace at this day the most elevated functions of strategy, it must be admitted also that logistics is no longer merely a part of the science of the staff, or rather that it is necessary to give it another development, and to make of it a new science which will not only be that of the staff but that of generals-in-chief.

The duties of the Marechal General des Logis expanded and took on new dimensions. [Ref. 26: p. 26]

2. The Middle Phase of Military Logistics

After Jominie expanded the dimension of logistics, Logistics did not long remain on this plane. In fact, it was eclipsed and, as we shall see, remained virtually so until World War II. THe man who cast the shadow was none other than Karl Von Clausewitz. In a very short of time, the leading military men of the world adopted the Prussian interpretation of Clausewitz's theory of war. Since he makes no mention of logistics in all of vom Kriege(On War), the concept of logistics lost most of military meaning that Jomini had given it. For example, about 40 years later, in 1876, an English major general published a dictionary in which he defined logistics as:

> With a reference to military science, it is the study of the military resources of countries, which forms part of the information gathered by the intelligence department of armies. [Ref. 26: p. 26]

In 1895, Edward s. Farrow, an instructor of tactics at West point, brought logistics back toward its original meaning but probably fathered a misconception mentioned earlier:

> Logistics is derived from Latin "Logista", the Administrator or Intendant of the Roman armies. It is properly that branch of the military art embracing all the details for moving and supplinging armies. It includes the operations of the ordnance, quartermaster's, subsistance, medical, and pay departments. It also embraces the preparation and regulation of magazines, for opening a campaign, and all orders of march and other orders from the General-in-Chief relative to moving and supplying armies.

In 1911, Comdr.C.T. Vogelgesang, an instructor at Naval War College defined logistics as:

> Logistics comprehends all the operations conducted outside the field of battle and which lead up to it, it regulates the execution of those movements which in combination become the function strategy. [Ref. 26: p. 26]

Logistics had not yet regained the position of a new science of warfare accorded to it by Jomini. A bright did appear in a book written in 1917 by Lt. Col. George C. Thorpe. He attempted to define logistics from view point of pure and applied logistics. In his preface, Thorpe says: the terms 'pure' and 'applied' may be used with the same meaning as to logistics as to other sciences. He defined pure and applied logistics as:

> Pure logistics is merely a scientific inquiry into the theory of logistics - its scope and function in the science of war, with a broad outline of its organization. Applied logistics rests upon the pure, and concerns itself, in accordance with general principles, with the detailed manner of dividing labor in the logistical field in the preparation for war and maintaining war during its duration. [Ref. 27: p. 9]

He also argued as follows:

1. Logistics is all that part of war which is not included in Strategy and Tactics.
2. Strategy and Tactics provide the scheme for the conduct of military operations: Logistics provides the means therefore.

Thorpe's influence was not immediately felt. In fact, many continued to regard logistics solely in terms of its application. For example, Farrow revised his dictionary again in 1918 and in it offered a definition of logistics which was succinct in comparison with his earlier work:

> Logistics - that branch of the military art which embraces the details of moving and supplying armies. [Ref. 26: p. 27]

A number of definitions of logistics that appeared during the 1920's and 1930's said essentially the same thing that Farrow said in his last revision. Logistics was doldrums. Apparently, nothing of note was done organizationary or otherwise that could have given logistics a push either in theory or in practice. However, WW II changed the situation - it made logistics a household word.

3. Post-World War II Development of Logistics

After WW II, two books were immediately published. One was "logistics in World War II" reported by the U.S.Army service forces. By its introduction, logistics was defined as:

> Logistics is the branch of the military art which embraces the details of the transport, quartering, and supply of troops in military operations. It also embraces all military activities not included in the terms "strategy" and "tactics." In this sense logistics includes procurement, storage, and distribution of equipment and supplies; transportation of troops and cargo by land, sea, and air; construction and maintenance of facilities; communication by wire, radio, and the mails; care of the sick and wounded; and the induction, classification, assignment, welfare, and separation of personnel. [Ref. 26: p. 27]

Now this was a significant development for logistics, and Thorpe's influence was felt. It occurred in one of the largest organizations ever assembled by man. Since one usually does not argue with success, logistics was accepted in the postwar years as much more than moving and supplying armies - the concept was expanded to include construction, communication, medicine, and personnel.

Another was "U.S. Naval Logistics in World War II" written by Duncan Ballantine. He provides one of the first broad-based definitions of the term, when notes that: "Logistics signifies the total process by which the resources of a nation - material and human - are mobilized and directed toward the accomplishment of military ends." Broadly conceived, the logistics process is thus the means where by the raw war-making capacity of the nation is transformed into instruments of force ready to be employed in pursuit of strategic or tactical objectives.[20] Ballantine also stated that "Logistics is both economic and military undertaking." He developed a theory which credited logistics as the "bridge" between the two elements necessary for a nation to wage war successfully - its military forces and its economic capabilities. [Ref. 5: p. 29]

After WW II, the formal military organizations[21] and scholars have devoted a great deal of their resources to the research and study of military logistics. Its importance as a function of war and as a primary organizational activity is widely recognized and constantly stressed at all level of command.

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[20] Duncan s. Ballantine, U.s. Naval Logistics in the second World War, Princeton University Press, p. 1, 1947.

[21] Military organizations include DOD, JCS, U.S Army Service Force, etc.

In 1953, Eccles attempted to develop pure and applied logistics which Thorpe suggested in 1917. He redefined pure and applied logistics as:

> Pure logistics is an abstract term used to indicate the whole complex process where by the means of war necessary to support a national strategy are determined, procured, and finally distributed to the combat commanders. Apllied logistics represents the everyday practical application of this abstract process. The applied logistics process of providing men materials facilities and services comprises the performance of many specialized and technical functions. [Ref. 13: p. 16]

He also stated that both pure and applied logistics can be roughly divided into two general classification: mobilization logistics and operational logistics. Mobilization logistics is the process that economic and industrial resources are mobilized in order to create and support the necessary combat forces and to maintain civil economy and health. Operational logistics include both strategical logistics and tactical logistics. Before operational logistics can be function, there must be the prior performance of the mobilization logistics function. Eccles emphasized that an understanding of both pure logistics and the broad aspect of applied logistics is essential to the exercise of high command. [Ref. 13: p. 16]

In 1961, Webster defined military logistics as:

> The planing, handling and implementation of personnel (as in classification, movement, evacuation) and material (as in production, distribution, maintenance) and facilities (as in construction, operation, distribution) and other related factors.[22]

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[22] Webster's Third New International Dictionary, G. & s. Merriam company, publishers, Springfield, Mass., 1961.

Further, a U.S. Air force technical report defines logistics as follows:

> The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, logistics pertains to those aspect of military operations which deal with; (a) design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel; (b) movement, evacuation, and hospitalization of personnel; (c) acquisition or construction, maintenance, operation, and disposition of facilities; and (d) acquisition or furnishing of services.[23]

In essence, logistics has primarily been oriented to "system/product support" and has included the elements of maintenance planning, test and support equipment, supply support, transportation and handling, facilities, personnel and training, technical data.[24]

Recently, logistics has been viewed on a much broader scale and the field of logistics has been growing at a rapid pace, stimulated primarily by the technological, sociological, and economic trends in our world. Systems and products have become more complex as technology advances, and logistics requirements have increased in general. Not only have the costs associated with system/product acquisition increased significantly in the past decade, but the costs of logistic support have also been increasing at an alarming rate. At same time, the current economic dilemma of decreasing budgets combined with upward inflationary trends results in less money available for the acquisition of new systems and/or for the maintenance and support of those items already in use [Ref. 28: p. 5]. In an attempt to respond to the dynamics of these situation, Graham W. Rider(1970), the Society of Logistics Engineers(SOLE:1974) and Fred Gluck(1979, 1982) tried to define military logistics from view point of each approach. In other words, every one has been saying the same thing but with different terms and at different levels of abstraction.

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[23] Gluck F., Technical Report No. 5, A Compendum of Authenticated Logistics Terms and Definitions, School of Systems and Logistics, U.S. Air Force of Technology, WPAFB, Ohio, 1970.

[24] DOD Directive 4100.35, Development of Integrated Logistics Support for Systems/Equipment, Department of Defense, Washington, D.C., October 1970

Graham W. Rider stated that logistics is conceived at three different levels of purpose or function. These three levels were defined as the social and economic purpose of logistics at the highest level; the system processes or steps through which the purpose is achieved at the second level; and the work functions or organizational tasks that must be perform to make the system work form the third level of the definition of logistics [Ref. 26: p. 32]. His culminating definition of military logistics as:

> Military logistics; The social and economic function of Physical Supply and Physical Distribution that creates time and place value for military goods and services. As a military organizational system, the purpose of logistics is accomplished through the processes of Requirements Determination, Acquisition, Distribution, and Conservation. The organizational work- functions or physical tasks that must be performed to accomplish the purpose of military logistics are Traffic Management, Supply, Maintenance, and Facilities Engineering. [Ref. 26: p. 32]

SOLE has expanded the definition of logistics to:

> The art and science of management, engineering, and technical activities concerned with requirements, design, and supplying and maintaining resources to support objectives, plans, and operations.[25]

This definition is conceptual in nature, and support the life cycle approach to the logistics. It includes both business and military logistics considerations. In addition, it addresses the establishment of requirements in the early phases of the life cycle and the subsequent design activities that precede production operations, product distribution, and the various aspects of sustaining system support during consumer use. [Ref. 28: p. 6]

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[25] This definition was established by the Society of Logistics Engineers(SOLE), August 1974.

Fred Gluck attempted to define modern military logistics from view point of weapons oriented logistics.[26] He defined modern military logistics as:

> The integrated management of those activities and resources necessary to create and sustain some required level of military capability [Ref. 29: p. 17].

Gluck commented his definition specifically as follows. The term military logistics is of a higher order than the term logistics environment for military logistics deals with the management of the logistics environment. Therefore, in that: (1) the total logistics environment is "organizationally fractionated" (i.e., broken into many small specialized pieces) while having a single end product, the most effective form of management is "integrative" rather than the present "coordinative."; (2) The identity of those activities, agencies, etc. which compose the logistics environment can be determined objective; and (3) the task/objective of the logistics environment is to create and sustain military capability. [Ref. 29: pp. 15-17]

Thus, our exploration of military logistics ends with a current trend of logistics. It is a long way from the original meaning of mathematical calculation and the later added meaning of lodging troops and ordering marches. Along the way, military scholars like Jomini and Thorpe have claimed that logistics is a science, but for most of the time. it was neglected or relegated to a series of tasks. [Ref. 26: p. 28]

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[26] In 1979, Military Logistics and A Concept of Modern Military Logistics, in 1982, The Necessity for Understanding Military Logistics and Military Logistics.... Toward Improved Effectiveness were published in Logistics Spectrum (magazine).

WW I and WW II brought logistics to center stage for military men. After WW II, a lot of military scholars and formal organization tried to develop the logistics theory and application.

Eccles developed pure and applied logistics theory which Thorpe suggested. He tried to define military logistics by dividing into mobilization and operational logistics. Rider analyzed the evolution of the concept of logistics, and then defined the military logistics from view point of three kinds of level(social and economic, system process, and work function). Eccles and Rider defined military logistics by dividing into several levels. Eccles derived the definition of military logistics evolution in prior 1953, Rider derived from the culmination of logistics evolution prior 1970.

SOLE's definition of logistics supports the life-cycle approach to logistics. It emphasized that one must employ a life-cycle approach in dealing with logistics today. SOLE's definition has recognized new approach in both civilian society and military organizations.

Fred Gluck defined logistics from view point of weapon oriented logistics, emphasized the necessity for understanding military logistics. He enlarged the scope of military logistics as follows:

1. Military logistics is a major segment of the military forces.
2. Military Logistics is one of three branches of the Military Forces. (the others being strategy and tactics)

Military organizations defined logistics from view point of each position and requirement. However, those definations have been recognized as unacceptable definition by military scholars like Gluck. Gluck insisted that "vintage World War II logistics" can provide only "suboptimization", in today's military environment.

These days, military environment is very flexible and dynamics. The nature of society is changing, and science and industry is producing new and more deadly weapons. Therefore, the objective of modern war reached new heights and the nature of war changed to conform [Ref. 30: p. 27]. Every country, which participate in the future war, will try not only defeat opposite military force but also paralyze the economic power in order to establish the political objective. Therefore, offical definitions of military logistics will be modified to respond to the dynamics of the situation and to the nature of modern war.

B. A CONCEPT OF MODERN MILITARY LOGISTICS

The importance of Military Logistics has been recognized everywhere in the world. Many military scholars and formal organization tried to define the military logistics in order to improve military force.

In today's Korean military environment, the advanced military logistics system is indispensable to improve our military force.

Therefore, one of greatest challenges facing the Ministry of National Defense today is more effective and efficient operation of military logistics. Toward this end, the following paragraphs are devoted to providing several new perspectives relative to military logistics as a background for the formulation of a concept of modern military logistics.

First of all, the concept of modern military logistics must be viewed in at least four dimensions. These are as:

1. Modern military logistics must contribute to national strategy.

2. It must be recognized as a major segment of the military forces.
3. It must be studied as one of three branches of military science(the others being strategy and tactics).
4. It must indicate the direction of development of military logistics system.

Viewing the entity of Military Logistics in the context of these four dimensions, understanding its role and significance can be logically developed as follows in order to derive the concept of modern logistics.

1. Future conflict in Korean peninsula, regardless of the particular kind of war, will require a lot of human and material resources. It will also require a professional military knowledge and a higher skill to operate the sophisticated military equipment. Most people will have to participate in direct and indirect military activity. Therefore we have to mobilize not only our internal economic and defense industrial resources but also organize human resources well. We have sufficient human resources but have insufficient material resourses. In view of the characteristics of future conflict and military environments, we can say that one of the most important factors is more effective and efficient management of our resources.

2. In a broad sense, War is a combination of military political, economic, and geographic situations and considerations. Here again we can find a variable blend of abstract terms, each of which is subject to a variety of meanings and descriptions, as well as to a variety of subdivisions; for example, geographic situations and considerations can include climate and weather; political considerations can include sociological aspects. However, military and economic considerations are related by logistics, since it is the military element in the nation's economy and the economic element in its military operations. [Ref. 13: p. 10-11]

3. In order to keep peace in Korean peninsula, we have been trying to establish the military balance between North Korea and Republic of Korea. Today, the military force of North Korea is superior to that of ROK, but ROK's economic power is greatly superior to that of North Korea. The economic power can influence on military force positively, but it is noted that major increases in defense spending are not the solution for all of the problems facing the improvement of military force. Therefore, we must make the best of military expenditure. To establish these objectives, military logistics must be integrated across the military complex and the nation's economic elements.

4. The primary function of military forces is to wage some level of war(armed conflict), when called upon. Therefore, in order to accomplish their primary function, military forces must always have a capability to wage some required level of war. In a broad sense, military capability includes force structure, force modernization, force readiness and force

sustainability. Force readiness is the ability of whole military organization to rapidly mobilize, deploy and fight. It includes the ability to receive units into the theater, integrate them into the operation and sustain them as long as necessary [Ref. 31: p. 2]. ⑩ To improve military capability, military logistics provides the technology to maintain required high readiness level and to sustain operations without outside assistance for reasonably long periods of time.

5. The logic of the statement that "the product of the total logistics system is military capability" can be reaffirmed by the use of third dimension.[27] This is

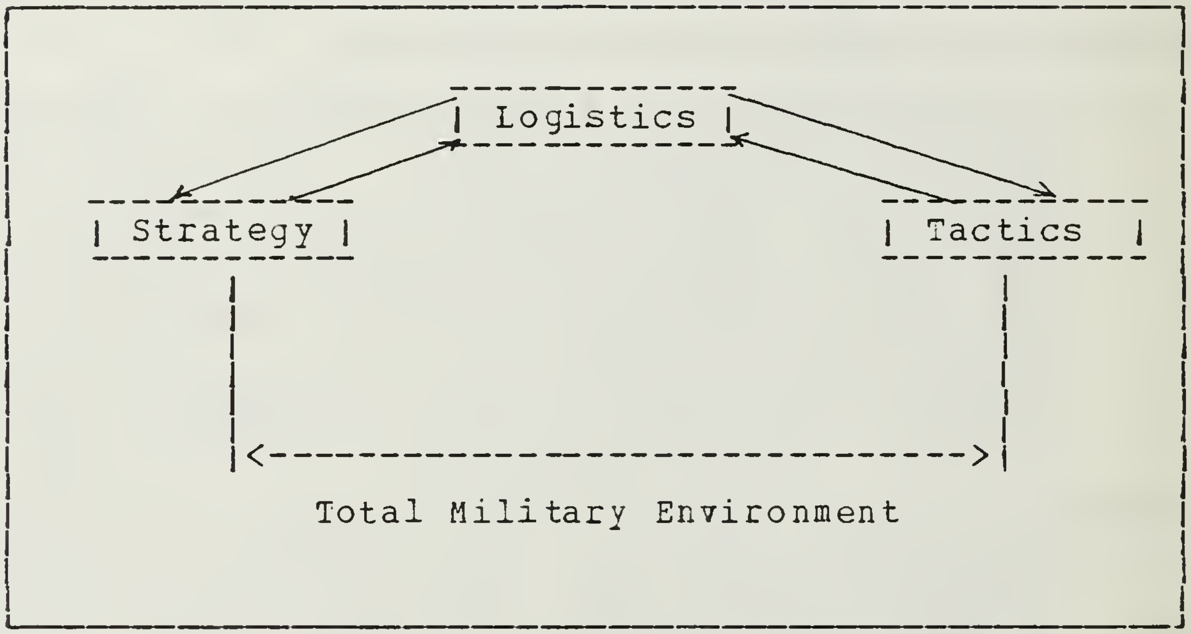

Figure 3.1 The Logistics Connection.

shown in Figure 3.1. It portrays a very simplistic view of the relationships between the three branches of military science (Strategy, Logistic, Tactics) from a logistics perspective. Strategy determines the required level of military capability to meet "threat" through the statement of need (SON) or the mission essential need statement (MENS). Logistics creates and sustains that required level of military capability, and tactics utilizes that military capability for waging war. Therefore, if military capability is the product of military logistics, then any activity, organization, or agency within the military forces which contribute to creating and sustaining military capability is in fact a part of the Military Logistics System (Environment) [Ref. 29: p. 15]. ⑪ The relationship between three branches can be differentiate by peace time and war time. During peace time, planned strategies and tactics shape the requirements of military logistics-through MENS, SON, and the level of combat training required. During war time, military logistics limits and shapes the strategies and tactics that can be implemented through the amount and type of military capability it provides to the combat forces. [Ref. 12: p. 32]

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[27] Modern military logistics must be studied as one of three branches of military science.

6. In that military logistics limits and shapes the strategies and tactics that can be implemented during the waging of war, tactical and theatre commanders must understand the ramifications of logistics decisions and actions. Therefore, in the formulation of strategies and tactics for and during the waging of war, some segment of that group would be better suited with experience in and understanding of military logistics rather than experience in the actual operation of the weapons involved (aircraft, ships, tanks, etc.). In wartime a valid assessment of the enemy's "logistics capability" will provide a theatre commander with a great deal more information, relative to the options open to the enemy, than only knowing the number and placement of their forces. [Ref. 12: pp. 32-34]

7. In creating and sustaining military capability there is a natural order to the major operations (segments) of the military logistics system. This sequence is

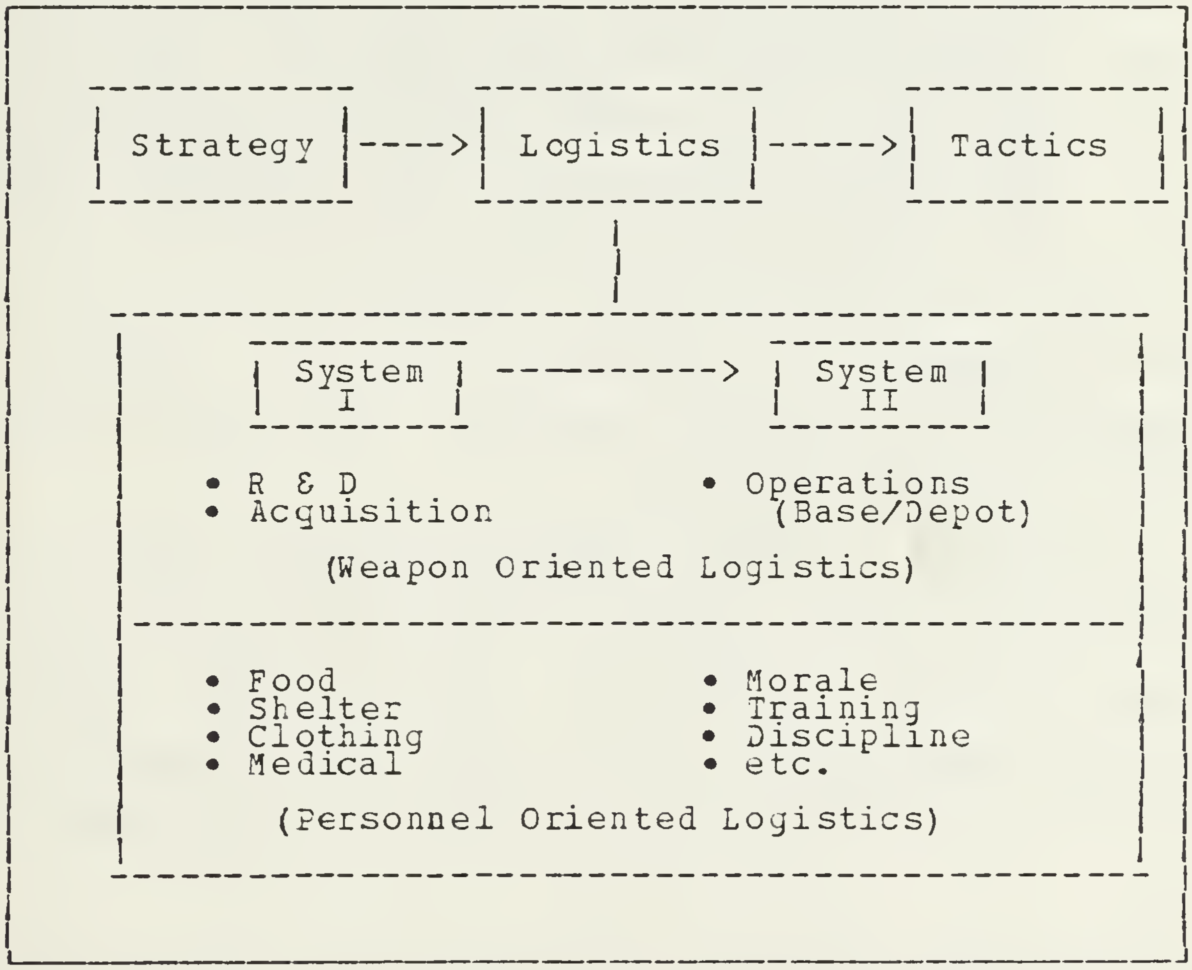

Figure 3.2 The Logistics Flow and Major Subsystem.

> shown in Figure 3.2. The Logistics Systems, in its upper segment entitled "Weapons Oriented Logistics." It breaks this logistics environment into two major subsystems, which in total create and sustain military capability. System I, which is composed of the R&D and acquisition operations, provides the potential for military capability through the acquisition of initial resources.[28] At this point, it must be stressed that the Acquisition of Resources (including weapons) in itself, provides no additional military capability to the forces. The requirement to increase overall productivity in resource-constrained environment has placed emphasis on all aspects of the system life-cycle. Therefore , military logistics has assumed a major role comparable to research, design, production, and system performance during operational use. The need to address total system life-cycle cost(in lieu of acquisition cost only) is evident, and experience has shown that logistic support is a major contributor to life-cycle cost - at least on the basis of those costs which are visible [Ref. 28: p. 5]. System II includes the base and depot level operations and assimilates those resources and creates military capability through its various functional activities[29] and process. "Personnel Oriented Logistics" is contained in figure 3.2 in recognition of the fact that it is part of the total logistics system. Although in the last several decades it has lost much of its visibility to weapons oriented logistics, it remains an essential ingredient in both the accomplishment of logistics objective and the primary function of military forces [Ref. 29: p. 16]. It is noted that good people can overcome the defects in logistics system, but even the best logistics system will not lead to satisfactory results without good people to operate it.

The preceding paragraphs delineate a few items of information necessary to understand the role, objective, and significance of military logistics, and set the concept of modern military logistics.

In summary, Modern military logistics is in fact the cornerstone of the military forces in that: (1)It deals with human and material resources; (2) It is very concerned with today's military environment; (3)It provides combat forces with the capability of waging war; (4)It provides tangible evidence of military power in deterring a military threat;

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[28] Initial resources include weapons, support equipments, initial spares, tools, test equipments, technical data and fuels, etc. [Ref. 29: p. 16].

[29] Functional activities include maintenance, supply, transportation, procurement and civil engineering [Ref. 29: p. 16].

(5) It limits and shapes the strategies and tactics that can be implemented during the waging of war; (6) its effectiveness directly impacts the cost and capability of military forces: and (7) It must be integrated across the military complex and nation's economic elements.

In view of these facts, an acceptable definition of modern military logistics might be: The integrated, artful and scientific management of those activities and resources necessary to create and sustain some required level of military capability to defeat against any kinds of enemy's attack. It does provide concisely the required art, science and integration of management concept, a general idea of its parameters and the objective - which it seeks to achieve the improvement of military forces. Modern military logistics has come of age. It is time for military logistics to enter the major segment of military force in order to improve the ROK's self-reliance.

IV. INTEGRATED LOGISTICS SUPPORT (ILS)

A. BACKGROUND AND CONCEPT OF ILS

Military concepts and principles have evolved to cover the necessary relationships between the three military arts of strategy, tactics, and logistics. These arts are important in achieving the basic objective of a military force-victory. However, James A. Huston indicates that military success often turns out to be less a game of strategy than one of logistics. He states that the outcomes hinge more on the logistical factors and implications than upon abstract gamesmanship. [Ref. 32: p. 8]

Military leadership, with its watch-dog agencies, require that every effort be made to minimize material and personnel costs while continuing to procure and maintain systems and equipment at a high state of readiness. Maximum material readiness may best be accomplished by employing the concept of total ILS. The term "Integrated Logistics Support" refers to a planning process designed to provide timely and effective support of systems and individual equipments. Essential to the understanding of this process is acceptance of the concept that the cost and adequacy of logistics support is a matter equal in importance to the cost and adequacy of the end item itself. [Ref. 33: p. 7]

To someone unfamiliar with the term, integrated logistics support may seem to be an example - one of a number of noncommunicative phrases that come into and fall out of vogue without ever being adequately explained fully understood. But logistics support isn't a meaningless phrase designed to obfuscate rather than communicate. It is, as some people might say, viable standardized wordage.

The ROK Army continually strives to develop and field materiel that can be adequately supported, to provide the logistics environment required to furnish the necessary support, and to minimize operating and support costs. Properly applied, ILS is a means to achieve these goals.

To provide a background against which integrated logistics support may be clearly defined, one must state the obvious: Logistics includes many functions and tasks performed by many organizations. When these organizations operate independently, the result of their combined efforts may be chaos rather than effective logistics. The integration and coordination of these diverse elements of logistics, starting early in the life-cycle of a materiel system, is the marrow of ILS. [Ref. 34: p. 14]

ILS is basically a management function that provides the initial planning, funding, and controls which help to assure that the ultimate consumer (or user) will receive a system that will not only meet performance requirements, but one that can be expeditiously and economically supported throughout its programmed life-cycle. A major ILS objective is to assure the integration of the various elements of support (i.e., test and support equipment, spare/repair parts, etc.). [Ref. 28: p. 13]

The ILS concept has its U.S. Department of Defense (DOD) beginning in systems acquisition efforts of the 1960's and is concisely defined in U.S. AR 11-8, Principles and Policies of the Army Logistics System, and it is addressed in greater detail in AR 700-127, Integrated Logistic Support, and in DOD Directive 4100.35, Development of Integrated Logistic Support for Systems/Equipments. These publications describe ILS as a process through which logistics considerations are integrated into the design effort and all elements of the logistics support system are planned, acquired, tested, and deployed. [Ref. 34: p. 15] It is also described by the Naval Material Command as:

> ...a process which identifies, in a systematic and orderly manner the functions which must be performed in support of operation and maintenance, and the resources needed to accomplish those functions. The process also requires that hardware and system design be reviewed with a view toward establishing hardware design and configuration which reduces, to the maximum practicable extent, the logistics burden placed on the operating forces. [Ref. 33: pp. 7-8]

One might wonder why logistics support need be considered during a system's design. The reason is that every decision made during the development of materiel system affects logistics support. For a example, a particular decision may mean that operational performance will be better once the system is in use, but at the same time that decision may mean that the system suffers more breakdowns and requires more time and cost to repair. The net result may thus be reduced readiness and higher support costs. Consequently designers must be constantly aware of the impact of their decisions on logistics support. The ILS concept provides for this awareness, requiring logistics support planning to be conducted in concert with system design.

ILS also promotes adequate consideration of the functional organizations responsible for personnel, training, test and support equipment, maintenance shop facilities, operating and maintenance publications, repair parts and components, and transportation and handling. This insures the coordination of these aspects to provide a complete support package. [Ref. 34: p. 15]

During the conceptual and validation phases of materiel system development, an effective ILS program influences the design of the system by identifying all pertinent support considerations. What logistics constraints - such as critical maintainability parameters and life-cycle support costs - are involved? What logistics problems or equipment deficiencies are present in similar fielded systems? What potential transportation problems exist? What special repair parts will be needed to maintain the system? What manuals will have to be published and circulated? Will special tools be required to repair the system? What test equipment will be needed to test the system? And what about training for maintenance personnel? These and other factors that impact on operational readiness, training, personnel, and cost must all be identified, along with possible alternatives to these elements of the overall support system. [Ref. 34: p. 16]

How can ILS contribute more to resolve some of those logistic problems; and why is the total concept of ILS not employed to satisfy the need so as to increase operability and enhance readiness? With the challenges and demands facing the manager, common sense is no longer an adequate guide to overcome the barrier. In these difficult times, one must reflect upon what is being done and how well the logistics support systems and equipments are being maintained. ILS by no means provides answers to all the difficult questions and logistic tasks, but it can serve to identify problems and to provide alternative ways to manage the systems and equipments, thereby enhancing readiness. [Ref. 33: p. 9]

Therefore, ILS is described as a composite of all the support considerations necessary to assure the effective and economical support of a system or equipment at all levels of maintenance for its programmed life cycle.[30] It is an integral part of system and equipment acquisition and operation and includes the integration of logistics considerations and logistics planning into the engineering and design process of systems, equipment, and modification program. [Ref. 35: p. 3]

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[30] DOD Directive 4100.35 Development of ILS for Systems/Equipments, p. 2, 1 October 1970.

In the next section, nine elements of ILS will be explained in more detail.

B. ILS ELEMENTS

To understand ILS, one must first understand the elements that ILS comprises. The principle elements of the ILS related to the system life cycle include:[31]

1. Maintenance Plan

A maintenance concept is derived from mission and operational trade-off analyses. This concept is then developed into a specific plan which identifies the resource requirements for all maintenance support actions. The maintenance plan is developed concurrently with the hardware design, and is updated to reflect design modification and change.

It also includes all planning and analysis associated with the establishment of requirements for the overall support of a system throughout its life-cycle. Maintenance planning constitutes a sustaining level of activity commencing with the development of the maintenance concept. And it continues through the accomplishment of logistic support analyses during design and development, the procurement and acquisition of support items, and through the consumer use phase when an on-going system/product capability is required to sustain operations. Maintenance planning is accomplished to integrate the various other facets of support. [Ref. 28: p. 11]

2. Supply Support

Supply support is an essential ILS element which involves the evaluation of alternative supply concepts, techniques, provisioning procedures, requirements determination methods, inventory control techniques, and supply facilities locations. It includes all spares (units, assemblies, modules, etc.) repair parts, special supplies, and related inventories needed to support prime mission-oriented equipment, software, test and support equipment, transportation and handling equipment, training equipment, and facilities [Ref. 28: p. 12]. The supply support plan provides for timely provisioning, distribution and inventory replenishment of spares, repair parts, and special supplies.

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[31] Most of contents of this section come from [Ref. 36] and [Ref. 28].

3. Test and Support Equipment

The principal consideration involved in the support and test equipment planning is to ensure that the operating forces are provided with all the essential support and test equipment required to perform both schedules and unscheduled maintenance actions. Support and test equipment consists of tools, metrology and calibration equipment, monitoring and checkout equipment, maintenance stands and special maintenance or handling devices. The identification of requirements, design development and evaluation of this type equipment must be accomplished concurrently with the design and development of the prime system. [Ref. 36: p. 28]

4. Transportation and Handling

This element includes identification of the actions and requirements necessary to ensure the capability to transport, preserve, package, and handle the prime system and all its associated and related support materiel. The transportation and handling planning effort is directed toward determining a cost-effective system for handling, packaging, transporting and distributing the prime system and its related support materiel. The transportation and handling plan provides for continual management and evaluation of the transportation and handling considerations throughout the life-cycle of the weapon system.

5. Personnel and Training

The personnel and training element is concerned with the quantitative and qualitative determination of numbers, skill levels, training, and assignment of all personnel required for the operation, maintenance, and support of the system or equipment under development. Initial planning efforts include an analysis of existing personnel manning capabilities and an evaluation of probable personnel requirements. The availability of personnel resources serves as a constraint upon the design and support decisions. The personnel and training plan identifies personnel manning and training requirements, and the training resources needed for test and demonstration, and operation and maintenance of the weapon system. [Ref. 36: p. 30] Authors would like to emphasize the importance of manpower aspects, and then more details of this part appears in the following section.

6. Facilities

The facilities plan defines the types of facilities needed to support the weapon system involved. Facilities include maintenance and supply facilities as well as those used for training. The plan also defines facilities location, space needs, environment, duration and frequency of use, maintenance and utility requirements, and development schedule. Because of the long lead-time involved in the government approval of military construction funds, the funding requirements for facility construction/modification should be accomplished as early as possible after system requirements are well defined. Facilities planning is based on operational and maintenance analyses, equipment design drawings, specifications, and other documentations. [Ref. 36: p. 29]

7. Technical Data

The purpose of the technical data effort is to provide timely development of the data involved in all aspects of system operation and logistic support, i.e., operations, maintenance, supply, training, modification, repair and overhaul. It includes drawings, specifications, provisioning documentations, operating and maintenance cards and manuals, computer programs, and inspection, test, and calibration procedures. The technical data plan must contain provisions to insure that timely and appropriate data calls are made and provided for decision-making purposes.

8. Logistic Support Management Information

The element is concerned with the type and quality of information required, establishing information flow, providing collection, analysis and control techniques, and determining hardware management information support requirements. This facet of support refers to all computer programs, condition monitoring and diagnostic tapes, and so on, necessary in the performance of system maintenance functions. [Ref. 28: p. 13]

9. Logistic Support Resource Funding

Budgeting and financing activities are primary to successful logistic support. Budgeting and financing activities include the identification of support cost factors by type and year and justifying these costs against budgetary requirements. Additionally, this element is concerned with providing accurate estimates of short and long range costs of the weapon system. That is, to provide total cost breakout by element with source of funding. In most cases this will involve Life-Cycle Cost(LCC) analysis [Ref. 36: p. 31] which will be studied further in the following chapter.

In summary, for large-scale systems the logistic support requirements throughout the life cycle are significant. The prime mission-oriented segment of the system must be designed with support in mind, and the various elements of logistic support must be designed to be compatible with the prime mission equipment. Further, these different elements of logistic support interact with each other and the efforts of these interactions must be reviewed and evaluated continually. A major decision or a change involving any one of these elements could significantly affect other elements and the system as a whole.

On the other hand, the logistics requirements for relatively small systems may entail only the functions of product distribution for the user and initial system installation and checkout, while the sustaining life-cycle maintenance support will be minimal. In this instance, the emphasis on logistic support and the design for supportability will not be as great as for large systems. The specific support requirements must be tailored accordingly. [Ref. 28: p. 13]

C. APPLYING ILS AND ILS PLANNING

Integrated logistics support is a widely misunderstood system life-cycle discipline. Yet ILS directly affects many important aspects of system acquisition, including such considerations as the control of program costs, full funding for priority programs, and cost versus quantity balance. The effect of ILS is most pronounced on testing and decision-making, and its application becomes more critical as system complexity increases.

1. Application of the ILS Concept

ILS provides the framework for the planning and execution of equipment development and acquisition to assure supportability and optimum life-cycle cost. To be effective it must be applied very early in the development phase, normally during concept formulation, to evaluate the general support requirements that could result from various design alternatives. These support requirements have a far-reaching effect on the life-cycle cost of a system since the cost of operation and maintenance in a 10-year period exceeds the acquisition cost many times over. As a consequence of inflation and the tendency toward increased equipment capability and sophistication, these costs accrue at a great rate each year. Without adequate control, these costs can erode the fiscal ability to develop and produce military materiel. [Ref. 37: p. 34]

When the materiel system enters the full-scale development phase, the emphasis of the ILS program centers on detailing support resource requirements, finalizing support concepts, and validating these requirements and concepts. Alternatives to the various elements of the support system must be analyzed and evaluated. And the supportability of the materiel system must be demonstrated to insure that the system meets Army supportability requirements.

During the production and deployment phase of the materiel system's development, the validated support system elements, including such items as maintenance manuals, tools, and repair parts, are acquired and deployed.

After deployment, equipment performance, maintenance, and cost data are collected, evaluated, and used for current maintenance management procedures. These data are also retained for use in product improvement and in future development programs.

The objectives of this ILS process are to insure that users receive a system that performs well, to insure that the system is adequately supported, and to reduce the cost of ownership of the system throughout its life cycle. The ILS process serves these objectives by influencing the design and acquisition of materiel systems - to insure that they are reliable and maintainable - and by timely planning, development, acquisition, testing, and deployment of required logistics resources as an integral part of the materiel acquisition process. Properly applied, ILS can improve system performance and availability, and it can minimize schedule delays and cost overruns by planning support actions rather than reactions. [Ref. 34: p. 16]

Integrated logistics support doesn't end with concept formulation. It becomes more ubiquitous as an item proceeds through its development phase and production. A smooth transition to the initial deployment of a system is a direct result of ILS planning and implementation. Lower system operational and maintenance costs in the field are related to the competence and dedication of maintenance engineers and specialists involved in a system's development. In brief, the deployment of a supportable system with a low life-cycle cost is not a stroke of luck. It is the result of an arduous process that must be systematically pursued throughout the acquisition phase. [Ref. 37: p. 16]

2. ILS Planning

The reliance on sophisticated equipment rather than on sheer manpower in future combat situations emphasizes the necessity for good logistics planning and places real importance on the integration of logistics consideration in the design process.[32]

Prior to the advent of ILS, operational performance was the only meaningful design parameter for new systems and equipment. Success of newly fielded systems was based on pure performance characteristics, such as range, speed, and payload. Logistic support was provided as an afterthought or after the design was so far along that significant changes could not be made. The need for superior equipment is valid both today and for the foreseeable future; however, suboptimization of operational performance has been accomplished unwittingly at the expense of logistics support.

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[32] Lecture Conference, "Introduction to Integrated Logistic Support," Army Logistic Management Center, Ft. Lee, Virginia.

In the mid 1960's the emphasis on suboptimization of operational performance was recognized and there was a turnaround in logistic support philosophy. Factors contributing to this turnaround in thought were:

1. Operating cost exceeded acquisition cost.
2. Unacceptable availability rates of major systems.
3. Excessive maintenance repair time.
4. Inability of the standard system to provide adequate support. [Ref. 38: p. 22]

The purpose of the ILS program is to improve operational readiness and logistic support management while minimizing operating and support costs. The irony of this paradox is that the expressed purpose is achievable. The key continuing objectives for achieving this purpose are:

1. Integration of logistic considerations into the design.
2. Timely availability of all required logistic resources. [Ref. 38: p. 22]

So far, this thesis is going to explain U.S. the Army's Integrated Logistics Support Plan (ILSP)[33] to illustrate the ILS Planning process. It describes the general concepts and strategy supported by a tentative milestone schedule. As the ILS program enters the Full-Scale Development phase, the milestone schedule and updated task requirements become more specific. The ILSP is inherently dynamic, yet it must be flexible enough to ensure the best overall balance among operational support elements. Figure 4.1 illustrates the ILSP outline. [Ref. 38: p. 22]

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[33] ILS Plan described in this thesis is based on AR 700-127.

PART I : GENERAL
1. System Description
2. Program Management
3. Applicable Documents

PART II : CONCEPTS AND STRATEGY
1. Operational and Organizational (O&O) concept
2. Acquisition Strategy
3. Logistics Support Analysis (LSA)
4. Test and Evaluation Concept
5. ILS Elements
6. Logistic Support Resource Funds

PART III : ILS MILESTONE SCHEDULE

Figure 4.1 Integrated Logistics Support Plan (ILSP).

The ILSP is divided into three basic parts:

Part I: General

This part addresses the system description, program management, and applicable documents.

1. System Description. - A brief description of the system and its equipment, purpose, and general performance characteristics. For example, for a 40-ton Crane Crawler-Mounted, the description would include details such as: diesel engine driven, full revolving (360 degree) superstructure, and a basic boom 50 feet in length. The purpose would explain its intended use, general performance characteristics, and the system's unique features.

2. Program Management. - Identification of all participating organizations and the level of program review. Participating organizations would constitute the appropriate project product manager, development command, and readiness command. The level of review for major systems would require either a Defense System Acquisition Review Council (DSARC) or Army System Acquisition Review Council (ASARC), while non-major systems would be limited to a local in-process review (IPR).

3. Applicable Documents. - A listing of documents which provide guidance or criteria for the functions described in the ILSP. Some examples of the types of

documents referenced are: Army Regulations, Department of the Army Pamphlets, Military Standards, Justification for Major System New Starts, and Required Operational Capability. [Ref. 38: p. 23]

Part II : Concepts and Strategy

This part is the focal point of the ILSP. It describes the basic concepts and the strategy for their achievement; in addition, it defines each of the ILS elements.

1. Operation and Organization (O&O) Concept. - This concept is expressed in terms of mission scenario, work environment, deployment plan, and support force structure. Examples of some of the concept concerns are: mission scenario - annual operating days and duration; work environment - ambient temperature; deployment plan - basis of issue; and support force structure - skill levels of support personnel.

2. Acquisition Strategy. - This subsection briefly describes the acquisition approach and relates the total acquisition strategy to the ILS program. It also addresses budget and funding plans that differ from standard procedures, i.e.; support cost guarantees, reliability improvement warranties, design-to-cost, and life-cycle costs.

3. Logistic Support Analysis (LSA). - LSA is required in all materiel acquisition programs. By regulation there are no exceptions. LSA is, however simple, an analysis that results in a decision on the scope and level of manpower and logistic support.[34] This subsection describes the LSA program in terms of LSA tasks, structure of LSA records, and contractor Government relationship.

4. Test and Evaluation Concept. - This subsection briefly describes specific test requirements directly; for example, reliability and maintainability, support personnel and skill requirements, training requirements, special tools and equipment, and adequacy of publications.

5. Logistic Support Resource Funds. - This element identifies ILS related life-cycle funding requirements, both funded and unfunded, by ILS element, major function, and appropriation. Cost estimating and accounting procedures must also be identified to assure that costing data will be translatable to the overall system and work breakdown structure reporting. Travel cost estimates for ILS coordination and management meetings should be treated as a separate element of cost. Justification should also be included for excessive cost and the effect of unfunded shortfalls. [Ref. 38: pp. 23-25]

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[34] AR 700-127, "Logistics - Integrated Logistic Support," 1 April 1981.

Part III : Milestone Schedule

This schedule shows the logical event-oriented sequencing for specific ILS tasks and events. The dates assigned are coordinated by the ILS manager for overall system planning to ensure integration into the materiel acquisition process. This schedule then becomes the baseline for logistic considerations and planning in the materiel acquisition process.

Finally, the concepts, procedures, and processes of ILS planning are not a panacea for all the problems associated with the acquisition and support of new sophisticated equipment. However, they do provide a system for the integration of logistic consideration into the design and the assurance of timely availability of all required logistic resources. [Ref. 38: p. 25]

D. TRAINING THE MANPOWER OF ILS

The purpose of this section is to review and evaluate manpower aspects of ILS planning. Manpower is the number of personnel authorized or allocated to a unit or agency within the Army. Hence, it is implicit within "Personnel and Training", one of the nine elements of ILS. Also manpower is the prerequisite for personnel procurement, distribution and training necessary to support a system acquisition.

The importance of a review of this particular ILS element is stressed by the fact that manpower workload unbalance such as shortage or untrained personnel can make continual problems in the maintenance of customer equipment and combat readiness.

1. The Nature of Logistics

Blanchard[35] states that logistic support management involves the planning, organization, direction, and control of all functions and activities relating to ILS. Most authors acknowledge that the form of management may vary from program to program, but none will concede the leadership that is needed to assure that ILS provides the efficient and economical system support required. According to Blanchard, the ILS manager should be high enough in the organization to provide effective leadership. [Ref. 32: p. 133]

From the time the raw recruit begins basic training until he leaves the Army, he is told to be "a soldier first, a technician second." What's good for the enlisted man is even more appropriate for officers: To rephrase the maxim, they should be leaders first and logisticians second.

During peacetime it is particularly easy to lose sight of the primary mission of the R.O.K. Army, that of defending our country from all threats, both foreign and domestic. This mission is applicable to all branches, logistical as well as tactical. We too often get caught up in our specialties - supply officer, transportation officer, food service officer - and forget that our primary concern should be to train our people to be sharp ground combat soldiers. Several years of peacetime training have allowed us to refine our doctrine and sharpen our management skills. But, in the process, have we neglected our leadership responsibilities?

Indeed, training and motivating the troops should be our primary mission. That has always been the primary mission of the Armed Forces. We need to recommit ourselves to this mission of leadership and we must train those under us to be equally effective leaders. Soldiers are more motivated by dedicated leadership than by sophisticated management techniques or monetary compensation. Thus, a good leader will produce a good unit, one that produces good logistics support. The fiber of today's Army can be improved by being a good leader as well as a good logistician. [Ref. 39: p. 36]

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[35] The author of "Logistics Engineering and Management"

Good things are happening across the whole field of logistics. Clearly, the Army's top logisticians are trying for a balanced program that best provides combat readiness. As we move deeper into the 1980's, we enter an extraordinary period of transition, embracing thousands of changes that are a part of reorganizing, reequipping, repositioning, and restationing. These ever-shifting priorities will be governed, one hopes, by an overall logistics plan that has as its basis a few verities. Lieutenant General John R. Galvin[36] suggests these:

1. Logisticians must be tacticians and tacticians must be logisticians.
2. Logistics management must catch up with technology.
3. Logistics training needs emphasis.
4. Logistics schools must coordinate more closely with field units.
5. Logistics must be simplified.

With our exploding world of technology, it is even more necessary today for the tactician to be a logistician: He who carries the modern saber must also carry a wrench. The equation works the other way, too: The logistician must be a tactician with a keen ability to sense the flow of the battle. [Ref. 40: p. 2]

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[36] U.S. VII Corps Commander

2. How to succeed in Logistics

"What should I do to be competitive in my military career?" Young and energetic Army officer logisticians are concerned about the kinds of things they should do to improve their competitive edge in vying for career development opportunities. Considerable thoughts are given to all logisticians who have pondered that question by Lieutenant General Richard H. Thompson.[37]

First, logisticians need to understand the Army, not only its missions and functions but also its values and beliefs. Regardless of current position or experience there are going to be occasions when their seniors will be perplexed, or even dismayed, by some of your attitudes. There is, indeed, a generation gap; but there are also core values and beliefs that they can jointly embrace and build a lifetime of service around. Thompson states there are three beliefs that can be universally shared:

1. The Army is a profession. - It is a profession that requires dedication, sacrifice, and commitment. Service to our country, in the highest and finest sense, is the principal reward.
2. The Army is people. - The Army is not an impersonal assembly of sophisticated weapons of destruction linked by high speed electronics. It is people, and people - comrades, family, friends, and countrymen - are whom the soldier is willing to die for.
3. The Army is opportunity. - The Army, as perhaps no other institution, offers the opportunity to serve, develop, grow, share, and contribute. [Ref. 41: p. 8]

He also says there are some fundamental values that can be mutually shared. Among those values are: Honesty and Integrity, Dedication, Pride, Enthusiasm and Optimism, and Respect.

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[37] He was Deputy Chief of Staff for Logistics, U.S. Department of the Army.

After recognizing these fundamental values and beliefs, somethings that a ycung logisticians can do in charting his career to maximize his contributions and to achieve his potential are suggested as:

1. Go after the tough jobs. Contrary to popular belief it can be beneficial to volunteer.
2. Stay physically and emotionally fit with a healthy appetite for work and a positive attitude toward mission accomplishment.
3. Serve with troops as early and as often as possible.
4. Learn to praise openly, counsel wisely and honestly, and chastise privately, impersonally, and without emotion.
5. Don't work toward efficiency reports and scores; give each job your best and the reports and scores will take care of themselves.
6. Learn to speak and to write expressively, understandably, and concisely.
7. Be active guided by technical knowledge, logical though, and common sense.
8. understand and learn from your mistakes.
9. Study war and understand it - it's your profession.
10. Care for your soldiers - help, nurture, and defend them; for they will be what they think they are and what you think they are.

Remember, logisticians are important members of the Army team. There is a bright future for you on that team. Attune yourself to become a more vital part of that team, drawing upon the emerging regeneration of Republic of Korea's defensive strength. [Ref. 41: p. 9]

3. Training Logisticians

a. The Role of Logistics in Combat Readiness

The four basic challenges to the Army will be the battlefield, leadership, readiness, and training. Forward deployed forces may have to fight on a few hours' notice and other components of the force may have only days or weeks to make final preparations for war. Therefore, commanders must have effective plans for those important days or weeks, and they must train for the specific missions they anticipate.

Unit readiness cannot be a reality without logistical readiness - the availability and proper functioning of materiel, resources, and systems to maintain and sustain operations on a fluid, destructive, and resource-hungry battlefield. The training of support units should be rigorously trained under conditions similar to those anticipated in combat. [Ref. 42: pp. 1.1-1.4]

The readiness of our Army to fight and win is the most critical issue we face and will require our concentrated support. Logistics support of readiness must be viewed as a double-edged sword, one with a human edge and a materiel edge. On the human side, we must have adequate, properly trained combat service support personnel to meet the challenges of an increasingly sophisticated fighting machine. These personnel must have the proper tools - that is, adequate parts, facilities, and the technical assistance to maintain our expanding inventory of weapon and support systems. There is an additional challenge to optimize the mix of active and reserved combat service support capability to maximize potential for sustaining the current and programed force. [Ref. 43: p. 2]

b. Training Logistics Units

Soldiers must be prepared for combat both professionally and psychologically. Training is the cornerstone of success and a full-time job for all commanders in peacetime, and it continues in wartime combat zones regardless of other operations or missions. [Ref. 42: p. 1.4]

How well is my unit trained for combat? This simple question with its far-reaching implications causes sweaty palms and sleepless nights for too many field commanders. The consequences of poor training are enormous. Training is, and always will be, the single most important mission any commander undertakes. The emphasis a commander gives training has a direct relationship to the quality of all command programs. Without good training, the commander will sooner or later fail.

Why, then, does the combat service support training mission seem so complex and difficult to accomplish? Simply stated, logistics unit require both tactical and technical training. That in itself is a tough task, but add a garrison logistics support mission and you get triple trouble. The approach to tactical and technical training requires a carefully planned, systematic program. Fortunately, a significant part of the technical training can occur more or less automatically because many combat service support units provide the same, or similar, services in garrison that they do in the field. If properly planned and implemented, garrison missions can complement field missions and strengthen the technical training base. This certainly is no panacea because every soldier cannot be productively in an MOS-related job while in garrison. However, opportunities are often available for rotation into MOS-related training positions. [Ref. 44: p. 16]

Therefore, commander has to consider following commonsense suggestions to reach at the training level of his unit successfully:

1. Orient soldiers to their role on the battlefield.
2. Review (or teach if necessary) and train in basic infantry skills.
3. Train for the field while in garrison.
4. Reinforce basic skills with "hardnosed" training.
5. Conduct tactical field training exercises.

6. Combine the tactical and technical.
7. Integrate tactical training with combat arms units.
8. Conduct a review and analysis of combat capabilities, roles, and functions.
9. Begin and end training with a good, commonsense plan.

> There are no shortcuts to good training. It is a hard, never-ending task that must be accomplished over and over again. It can be fun and exciting provided soldiers see the purpose and are led by competent, well-trained leaders. As commanders, we are responsible for successful training. We must it happen. [Ref. 44: p. 18]

c. Precommand Courses for Logisticians

> Formal training includes in ILS terms both _initial_ training for system/product familiarization and _replenishment_ training to cover attrition and replacement personnel. Training is designed to upgrade assigned personnel to the skill levels defined for the system. [Ref. 28: p. 12]

Major changes in officer education will insure that tomorrow's regiment and battalion commanders are prepared to meet the logistics challenges and demands of future war.

This thesis will suggest following the example set by the U.S. Training and Doctrine Command (TRADOC) in its implementation of combat arms and combat support precommand courses, the Army Logistics Center, and developed a four-phase combat service support precommand course for lieutenant colonel and colonel command designees. It encompasses home study, resident study at either the Logistics Center or one of the four combat service support schools (the Missile and Munitions School, the Transportation School, the Ordnance School, the Quartermaster School), plus resident study at the Command and General Staff College. [Ref. 45: p. 9]

This proposed example can be compared with R.O.K. Army training system for logisticians in Logistics School, just established, or each of combat service support schools, and will suggest one of sample model to study and develop our system efficiently.

The logistics command designee will complete four phases of precommand training before going to his new command assignment; these phases are as follows:

Phase I: Home Study.

Before an individual attends one of the logistics precommand classes (phase II), he must first complete a self-paced, home-study phase. A home-study packet is mailed to each command designee 3 months before he is scheduled to attend phase II classes. Depending on which of the phase II classes the Military Personnel Center projects for the officer, he receives correspondence course material for one of three Logistics Center home-study tracks - for those projected to become DISCOM commanders; for those projected to become COSCOM commanders; or for those projected to become support battalion commanders. Additionally, each of the four associated logistics schools sends a singular function-oriented home-study package to its designees.

The home-study phase requires about 15 hours for completion. It includes an update on Field Manuals, writings by former battalion commanders, and a handbook for future battalion commanders. There is also an optional diagnostic test covering both tactics and logistics, with an accompanying study guide. Those choosing to complete the diagnostic exercises may mail them to the Logistics Center or one of the associated schools, where they will be graded and returned along with an explanation of the correct answers. Test results will be evaluated and areas recommended in which the command designee may need additional review before attending the resident phases. [Ref. 45: p. 10]

Phase II: Logistics Precommand Classes.

During phase II, the logistics officer will attend a 2-week course at either the Logistics Center or one of the four combat service support schools. Individuals who are destined to command units with several logistics requirements - maintenance, supply, transportation, ammunition, and quartermaster - will attend the course conducted at the Logistics Center. These "multifunctional" command designees are further divided into five different tracks, depending on whether their future assignment will be with a corps support command, division support command, support group, area support group, or support battalion.

Organizational logistics is stressed during the first week in all combat service support precommand courses. The second week focuses on training management and course content reflects the job-task surveys conducted by the service schools in coordination with TRADOC. Critical subjects for each type of command designee are determined from the respective service schools' job-task analysis.

Many of the course instructors have recent, branch-specific field experience. Performance-oriented training management instruction is supplemented by discussions with former company commanders and tours of motor pools, supply rooms, and arms rooms. [Ref. 45: p. 10]

Phases III and IV: Precommand Training at Command and General Staff College

Upon completion of the 2-week logistics precommand class, the officer joins a class of other command selectees from the combat arms and the combat support schools. There , he is given an additional week of command development instruction and a week of "how-to-fight" practical exercises.

The command orientation of the third phase provides new field commanders with insight into the human elements of command - management of human resources, organizational effectiveness, drug and alcohol abuse, women in the Army, and chaplain functions. Among the other topics considered during this phase are tactical battlefield logistics and the computer-assisted tactical training system, logistics wargaming which is introduced in the next section.

The final phase of the precommand course, phase IV, is better known as the "how-to-fight" phase. It helps command designees apply the skills learned or reviewed during their home-study, their 2 weeks at the Logistics Center or one of its associated schools, and their first week Command and General Staff College. A combination of tactics and logistics exercises is designed to reinforce the functional skills and reacquaint future commanders with management and leadership problems normally found in the type of unit they will command. Students will be given problems that require them to apply principles of leadership and management as well as a knowledge of their functional area.

After completing the four phases of the logistics precommand course, new commanders are better prepared to play their important role in insuring the survival and ultimate success of our military forces. The emphasis of the precommand program for logistics clearly is that of supporting the Army in the field. [Ref. 45: p. 11]

4. Introduction of Logistics Wargaming Model

In this section, the 'ATLAS' model which is used in the US Army is introduced briefly for development of Korean Army's logistics wargaming. Wargaming was first introduced as a means of helping combat arms commanders develop and practice battlefield strategy. It wasn't until much later that wargaming included logistics considerations, however. Until recently, logistics gaming was limited to division-, corps-, theater-, or Army-level games. [Ref. 46: p. 36]

The 1973 Middle East War made people see that tactical wargaming unquestionably lacked realistic logistics considerations. The War also showed that logistics would play a decisive role on the modern battlefield. The Army that can keep its weapon systems operating will more than likely be the winner. Since the 1973 War, emphasis has been placed on integrating logistics aspects into wargaming, including realistic logistics planning and support.

One result of the shift in emphasis was the development of the maintenance management exercise called 'ATLAS'. Developed by the Ordnance Center and School, ATLAS allows battalion logistics managers to make realistic maintenance and supply decisions. Because it is a free-play manual wargame, it can be tailored to fit the training needs of any maintenance battalion.

As usually played, ATLAS calls for participation of the battalion commander, his primary staff, the materiel officer, and the company shop officer. Decisionmakers at each level, from the company shop officer up to the battalion commander, make decisions based on the tactical situation, current priorities, and the availability of resources. The results of these decisions become readily apparent as the game progresses. [Ref. 46: p. 36]

The method of play is designed to simulate the normal activities of a maintenance battalion. The game is based on the management of 40 major end items. Since this is approximately half the normal supported density, each soldier can be worked for only half the normal hours of every game day.

The game begins with backlogged shops as indicated in the maintenance control system reports issued to the materiel office and each shop office. These reports show the open work request register, the deadline detail listing, the battalion workload status, and workload summary listing. Each shop officer is provided with a preloaded tub file of jobs, a tag for each soldier by grade and MOS, a shop stock preloaded to 90 percent fill, and a tag for each organic vehicle. Game time is compressed so that each played game hour represents 15 minutes of real time.

As the first game day begins, the shop officer assigns personnel (represented by the tags) to customer jobs either in shop or awaiting shop. Simulated forms cut down on the time required to complete paperwork necessary for control at the company and battalion level. Work requests are represented by computer cards listing the item of equipment, its fault, the part required, and the man-hours necessary for repair.

Each game day starts with the rolling of a die to determine maintenance requirements and equipment combat losses. The same procedure is followed for personnel losses. To add realism, recovery of mired or damaged equipment is also played. The shop officer, using computation tables designed for that purpose, computes travel time, hookup time, extraction time, unhooking time, and return time on any recovery mission. There is also an operational readiness float available for play if the battalion commander so desires. The commander can modify the game to emphasize any maintenance area he feels is important for his unit. [Ref. 46: p. 38]

The tactical scenario, which is provided along with maps and overlays showing the location of all friendly units, indicates the enemy has attacked and is regrouping, while the friendly forces are maximizing efforts to repair and return as much equipment as possible to the combat units. With this in mind, each shop officer uses his soldiers, equipment, and time to return equipment required by his customers quickly. But, no matter how hard the shops try, they can't keep up and quickly become completely overloaded.

Critical parts are required and decisions must be made. One such decision might be whether to expend the man-hours to go to a cannibalization point or to repair some other piece of equipment for which the parts are already on hand. The battalion commander and the materiel officer must establish priorities for equipment repair, moving personnel from one unit to another and equalizing workloads. The supply officer must decide when and where to cross-level parts, keep track of cannibalized parts available, expedite high priority requests, and keep the materiel officer informed of the status of critical repair parts.

ATLAS is a training-oriented game, the results of which are not normally given tc higher command levels. It was designed to be an internal training device that tests the existing operating procedures within the battalion with emphasis on rapid, factually based decisionmaking.

Since ATLAS is designed to teach more effective decisionmaking, it isn't a graded exercise. The results of the game are provided solely to the players involved and become a method of internal evaluation of standard operating procedures, effective coordination, and efficient utilization of personnel, equipment repair parts, and time. [Ref. 46: p. 38]

E. ILS - PREREQUISITE FOR IMPROVED OPERATIONAL CAPABILITY

At no time in the history of our country has the need for improved logistics support of Korean Army been more critical than it is today. National Security, in a peace time era, really suffers because the longer the people enjoy the peacetime, the less motivated they are to 'keep their guard up' against any hostile acts. [Ref. 47: p. 10]

1. Teamwork in Readiness

Success on the modern battlefield will depend upon two things: the well-trained individual soldier and the proper functioning of his equipment. Effective training and actual combat both require maximum operational equipment. Anything done to improve equipment readiness rates and make more equipment available for training will improve a unit's chances of success on the battlefield.

Although the responsibility for operational readiness falls upon the shoulders of the unit commander, he alone cannot assure that the unit will meet its readiness goals. Success in readiness, like success in combat, requires a team effort consisting of the organization and its direct support unit (DSU). Keeping today's sophisticated equipment functioning with the limited resources available is no easy task. Equipment readiness is just one of several problems that beset each unit and each direct support unit. The priorities and resources of the customer unit and the direct support unit differ significantly.

The disparity of priorities and resources sometimes results in animosity among the units. Unit personnel complain: "We can't get parts," or "The DSU never supports us." Direct support unit personnel, on the other hand, complain: "The units don't cooperate," or "They want us to do their work for them." These complaints are usually more perceived than real, but they do detract from the team effort and hurt readiness programs. [Ref. 48: p. 10]

Most units and their DSU's do what the regulations require, and often a great deal more, in their efforts to meet readiness goals. Yet, some units succeed in meeting their goals more often than others. Why?

An analysis of the relationship between the most successful customer units and DSU's reveals a common element. They all stress cooperation and coordination. They have adopted special procedures or extra efforts to help the other unit do its job better or easier. The procedures are not always required or supported by Army regulations, yet they do seem to produce higher mission capable rates. There also seems to be a friendly rapport between the DSU and its customer units.

How does your unit rate in meeting its readiness goals? Could a better DSU-customer relationship help improve your readiness rates? Any commander or supervisor can examine his unit and its DSU-customer relationship by asking the series of questions that follow. The questions are not all-inclusive and not all of them will apply to every unit. Read the questions and consider how your unit functions as a member of the readiness team. [Ref. 48: p. 11]

Questions for customer units:

1. Does the unit commander and the maintenance officer visit the DSU at least once a month? Do you expect the DSU to juggle resources and priorities for your unit without knowing your problems?
2. Are supply issues and completed job orders promptly picked up from the DSU?
3. Are repairable items packaged correctly and promptly turned in to the DSU?
4. If there is an urgent need for a specific item of equipment or if the DSU has an excessive backlog, does your unit offer to help?
5. When the DSU does an exceptionally good job or renders special support, do you tangibly acknowledge it?
6. When equipment is taken to the DSU for turn-in, is it clean? Are all organizational maintenance faults corrected as completely as possible?

Questions for direct support units:

1. Are customers furnished a copy of your standing operating procedure that clearly and concisely tells how work orders, supply requests, and turn-ins of

unserviceables are processed? Does it explain how assistance requests are handled and how float items are issued?

2. Does the DSU commander, shop officers, and technical supply officer occasionally visit customer units and periodically attend their readiness reviews?

3. Are contact teams provided for some on-site repairs and for most field exercises?

4. When equipment is inspected for acceptance into DSU maintenance, does your unit provide the customer with the space and tools needed to correct organizational discrepancies?

5. Does your DSU accept and act on emergency supply and work requests regardless of the hour of the day or day of the week?

6. Does your DSU shut down one afternoon a week for training or internal maintenance?

7. Do the key personnel of your DSU know the readiness posture of customer units on a day-to-day basis, or does your DSU complete job orders and issue parts strictly on the basis of the age and priority of the request?

8. In a real crunch, will your DSU lend tools, test equipment, and a supervisor to help a unit complete repairs not specifically authorized on their maintenance allocation chart?

9. Does your DSU routinely check other support units and cannibalization points to obtain missing parts that are delaying the completion of job orders?

10. Does your DSU routinely correspond with higher headquarters?

The direct support unit and the customer unit are members of a team whose common goal is to achieve the highest possible equipment operational readiness rates. This goal can be achieved only by laying aside unit rivalries and local prejudices. There is no room for blaming other units for poor readiness rates. Excuses such as "It's not our mission," or "It's not required by regulation," are really no excuses. The customer unit and the direct support unit must function as a frictionless team if the Army is to success in both peace and war. [Ref. 48: pp. 11-13]

2. ILS Management Team (ILSMT)

The task of developing the logistics support required for a materiel system is similar to that of developing the materiel system itself and is subject to the same types of problems. Where the materiel system has many technical characteristics that have to be balanced and integrated, the logistics support system must balance and integrate such functional elements as supply support; rationalization, standardization, and interoperability; packaging, handling, and storage; maintenance; support equipment and test, measurement, and support equipment; transportation and transportability; computer resource support; and facilities. In addition, logistics support and the materiel system design must be integrated. As with the technical characteristics of the materiel system, no single logistics element can be pursued independently to the exclusion of all others. [Ref. 49: p. 32]

This thesis explains US Army's ILSMT to illustrate a management tool that has been successfully for several years in developing life-cycle logistics support during the materiel acquisition cycle. Army Regulation 700-127, Integrated Logistics Support, dated 1 April 1981, establishes the requirement for the team for all major and designed nonmajor materiel system acquisition as a part of the overall integrated logistics support function.

Much as the system engineering design review process is the key to successfully developing materiel, the face-to-face meetings of the ILSMT members representing the various logistics functional elements serve the same purpose for developing logistics support. At this meetings, the total attention and energy of the members can be directed to resolving current problems and anticipating future ones.

The ILSMT operates under a formal charter that identifies and defines the duties of the team and its members. The charter should be as specific as possible in describing what the ILSMT will do to eliminate duplication, reduce acquisition and operating costs, improve integration of support elements, provide a logistics influence on design, resolve schedule and contract conflicts, reallocate program funds and priorities, and redirect contractor efforts. [Ref. 49: p. 32]

Therefore, this thesis proposes that ROK Army headquarters as well as Ministry of National Defense has to organize more effective system such as ILSMT for improved ILS as soon as possible.

The team is chaired by the integrated logistics support manager for the materiel acquisition. Participants come from the functional logistics elements within the materiel readiness commands such as technical publications, new equipment training, provisioning, and others. Functional elements of the materiel development commands such as reliability and maintainability or design engineering should also be represented. Membership should be extended to the Logistics Evaluation Agency, the Materiel Readiness Support Activity, and the Army Materiel Systems Analysis Activity. Participation by the Army Training and Doctrine Command (TRADOC) including the representatives of it's proponents is considered essential. Other representatives should come from the integrating centers, the logistics-oriented schools, test organizations, and the Training Support Center.

Many times ILSMT members participate in other team or group activities associated with the same materiel acquisition program. For example, one member may participate in the test integration working group while another may be a member of the logistics support analysis review team. This practice greatly improves the coordination process.

Participating organizations should designate a primary and an alternate ILSMT member and should insure that only the primary or the alternate member attends the meeting. This eliminates the need to spend time orienting participants who are not familiar with the acquisition effort. Additionally, the size of the ILSMT must be rigorously controlled. Even when only the essential ILS considerations are represented, the team can quickly grow to 15 or more members. Teams this large or larger become hard to control and lose much of their group dynamics. [Ref. 49: p. 33]

Before the meetings, the ILS manager should determine the central theme and circulate a message requesting team members to furnish related agenda items. This gives the ILS manager control over the meeting while satisfying the needs of the ILSMT members. After receiving input, the ILS manager should establish the agenda and furnish it to participants before the meeting.

Every effort will be made to complete action on all agenda items at the meeting. If action is not completed or a problem is not resolved, the ILS manager will designate an action office to report at the next ILSMT meeting. Minutes of the meeting should be distributed to participants as quickly as possible. The publication of minutes keeps participants informed and documents the ILSMT effort.

The ILSMT offers an excellent tool to accomplish the many ILS actions required during the materiel acquisition cycle. Although there is expense involved in exercising this tool, the resources required to sustain the ILSMT are more than justified when compared to the expense of fielding a materiel system that can't be logistically supported. [Ref. 49: p. 33]

3. Some Considerations for Improved ILS

a. Industrial Logistics Considerations

Operating a military organization in less-motivated atmosphere is quite difficult. There is just not enough budget available to provide for all the needs which the security experts require, and inflationary pressures continue to shrink these expenditure. This is also true in the industrial sector. Those industries which are producing for military requirements are facing severe difficulties. They are keenly aware that preservation of the military oriented industrial base is required as part of the peace-time security structure. They are also aware of the three important roles they must play:

1. Continuing research and development of new systems to improve our security arsenal and stay ahead of potential hostile nations.
2. Providing the facilities and production planning base for manufacture of equipment in support of any mobilization requirement.
3. Life-cycle support of equipment already in the military inventory as well as improved logistics planning for future requirements. [Ref. 47: p. 10]

Carrying out these roles in times of tight budgets is most difficult. Both the military and the industrial base must trim down and do their jobs more efficiently. To do this, two basic tenets must be adhered to:

1. The military must concentrate their energies and resources on the tactical and strategic needs of national security plan.
2. Industry must devote their facilities and resources to provide total support of the security plan.

A typical defense related industry provides three basic functions relating to their product; they design products, produce products and support products. In doing this, the more progressive concerns usually organize along these specialized functions. The results achieved are higher quality, lower cost products and more responsive support to the user. Figure 4.2 shows such a basic industrial organization.

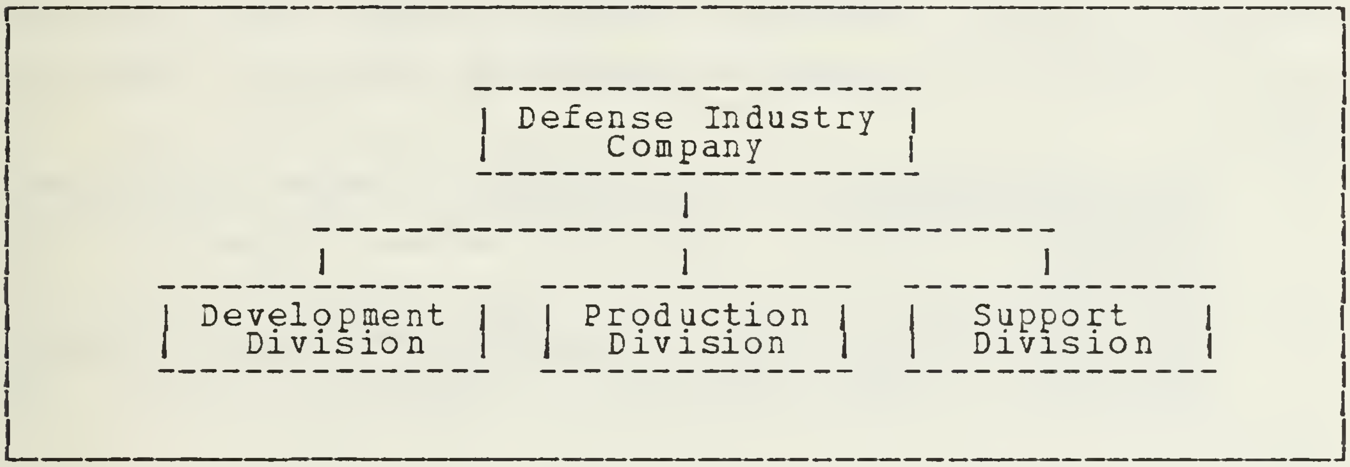

Figure 4.2 **Typical Defense Industry Company Organization.**

Within such an organization, products or systems are usually created from the research in the Development division. Should pre-production or production requirements emerge, the Production Division would take the lead. Once the product or system reaches the termination of production, the Support Division takes over management. Program management can reside in any of the three divisions, depending upon the maturity of the particular product or system. In any case, all three divisions are a part of the program team. [Ref. 47: pp. 10-11]

The primary objective of any logistics support organization must be to satisfy customers. If the products and services of a logistics industry cannot accomplish this, it will soon be out of business. Customer satisfaction must also be backed up by satisfactory profits. More specifically, a logistics organization should be committed to provide total life-cycle support of the systems being sold. The equipment being supported must be kept operable and it must be done for a minimum expenditure. Total acquisition cost and total support cost add up to total cost of ownership. Minimizing cost of ownership is the objective that the logistics organization must strive for.

To attain this objective on any program, the Integrated Logistic Support Program Manager must be challenged to achieve successful results in complying with two policies:

1. ILS Policy No.1 - The ILS program manager is responsible for creating, implementing, and continuously up-dating a total life-cycle support plan for his program.
2. ILS Policy No.2 - The ILS program manager is responsible for creating, implementing, and continuously up-dating a total business or strategic plan for his program.

Addition of Policy No.2 is the first unique feature of the ILS organization which has total business management responsibility. This type organization has the resources and authority to act to achieve total support of a program without outside assistance. [Ref. 47: p. 11]

There are two additional life-cycle support considerations which deserve attention. The first is the idea of establishing and maintaining a spares production capability for contractor sourced spare parts. These items are usually unique to the system they are used in. They also usually require relatively expensive manufacturing facilities and test equipment. During production build-up, spares production can be gotten from production lines with proper planning. On the other hand, during production phase-out, surplus production tooling required for spares and repair should be transitioned from the production facility to the support facility.

The second life-cycle support consideration which reduces cost is the concept of combining factory test requirements with customer test requirements and giving the logistics test products organization responsibility for both. In this new era of reduced spending and more reliance on contractor support, as well as the increased design-to-cost emphasis, such a combination is both efficient and cost effective. Factory test and depot test are both done primarily with commercial equipment, and, thus should be either identical or quite similar in configuration. Field test requirements should be minimized through increased use of built-in-test (BIT). The 'BIT' can also be utilized in both depot and factory for production and repair checkout.

In summary, the most effective logistics organization is one which (1) handles the people problems through its functional organization, (2) handles profit problems through its product line organization, and (3) handles total support integration problems through its programs organization. Doing these three jobs simultaneously is quite difficult and requires an extensive range and depth of good management personnel. A good logistics organization is thus probably heavily endowed with competent management. The concept will not work, otherwise. [Ref. 47: pp. 11-13]

b. Logistics Research and Development Program

Readiness of the Army is getting the highest priority in the allocation of resources. Efficiently managing these resources is presenting defense logisticians formidable challenges in procuring and fielding the large numbers of new and sophisticated weapon systems entering the inventory. Our military systems must also continue to be technologically better than those of our potential adversaries in order to counter their superiority in numbers.

Together, these two requirements present a logistics management dilemma: how do we maintain the Army's readiness at the same time we improve its technological edge? And how do we balance resource requirements to realize both goals? [Ref. 50: p. 14]

Dr. Korb[38] has described logistics research and development (R&D) as "the application of technology to reduce logistics and weapon system requirements for our forces." Following Dr. Korb's lead, the US Department of the Army (DA) has further defined logistics research and development as "the application of science, technology, and research and development disciplines to anticipate and solve logistics support systems deficiencies through existing appropriation channels."

Perhaps to more clearly understand what logistics research and development is, is to say what it is not. The essential difference between logistics research and development and existing improvement programs - such as ILS; reliability, availability, and maintainability; and product improvement programs - is, quite simply, that logistics R&D is more generic in nature. This philosophy treats logistics systems across the board as a separate functional area, distinct from the support of a specific weapon system, and thus ensures that improvements in logistics systems and methods get equal billing with weapon systems development and paves the way toward logistics support continuity in supporting the 'fluid battle' scenarios of the future.

Logistics research and development efforts can be categorized into three broad areas - management processes, logistics systems, and generic technology improvements. [Ref. 50: p. 14]

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[38] US Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics.

Some examples from these areas may further clarify the differences in traditional research and development activities and those anticipated through the logistics research and development program. Let's examine technical data management as a logistics R&D effort that also involves a management process. This project seeks to improve the management and flow of technical data through automation from the contractor's plant to the ultimate user - the soldier in the field (see Figure 4.3). Data emerges from a contractor's plant and becomes incorporated into engineering drawing. These are placed into a digital storage and retrieval system, controlled by a technical data management system. These data then flow through the provisioning master record and logistics support analysis records to automated publications and, finally, to user electronic display devices. Technical data automation could, of course, be addressed as an integrated logistics support element if it were being addressed only as it applied to a tank or other weapon system; but when addressed from the logistics research and development point of view it would encompass state-of-the-art data automation technology applicable to all weapon systems and logistic support system. [Ref. 50: pp. 14-15]

All organization levels within the Army need to become involved as the logistics research and development program evolves. There needs to be a coordinated effort among the Army's logistics research and development players. Figure 4.4 depicts the coordination and information exchange that is needed throughout the logistics R&D process in US Army (Korean Army has similar type of organization).

How will the logistics R&D process be institutionalized within the Army? The combat service support mission area analysis will serve as the foundation for building a long-term logistics R&D program. From this

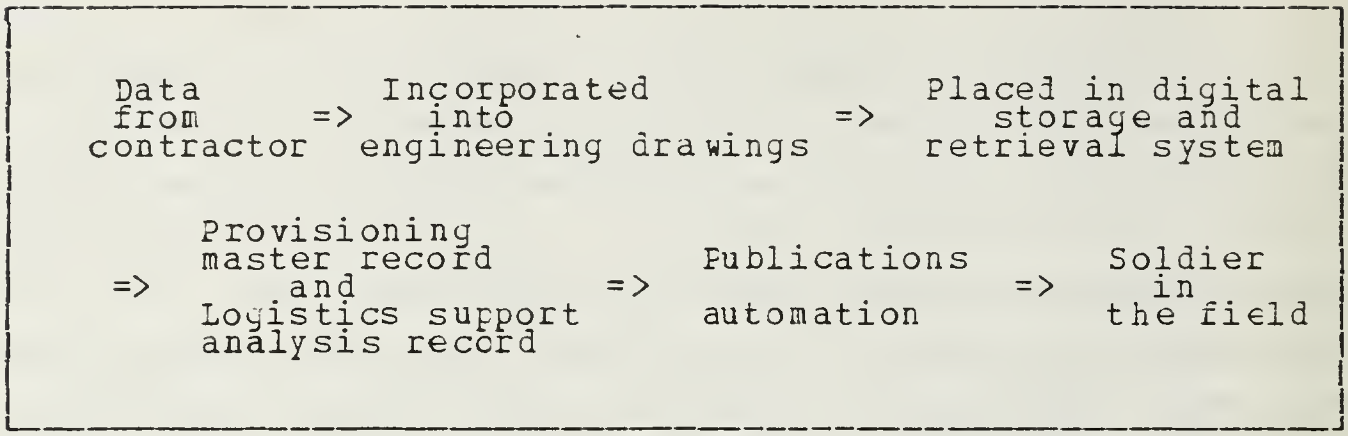
Data from contractor
=>
Incorporated into engineering drawings
=>
Placed in digital storage and retrieval system
=>
Provisioning master record and Logistics support analysis record
=>
Publications automation
=>
Soldier in the field

Figure 4.3 Technical Data Flow Management.

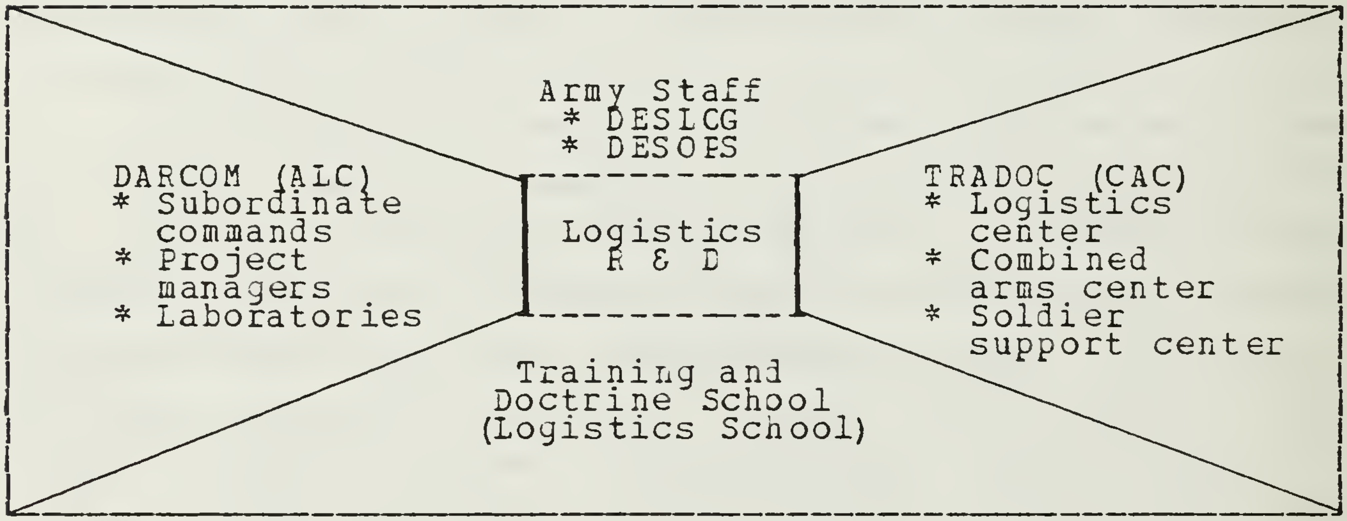

Figure 4.4 R&D Coordination/Information Exchange Concept.

mission area, logistics R&D projects will be generated. In developing the management framework for logistics R&D, we must also improve the combat service support mission area analysis methods. A master plan for the combat service support mission area under development will serve as a road map toward other potential logistics R&D projects.

Over the long run, the logistics R&D goal must be "to develop a streamlined logistics structure that promotes high weapon system availability and rapid, flexible deployment capability," to quote Dr. Korb.

Logistics R&D is a tool that can be used to ease the logistics burden of the soldier by making the combat service support system work more effectively. Current R&D methods do not adequately incorporate the input of the readiness logistician. This program serves to focus the attention of the researchers and developers on long-term readiness needs. In the short run, projects such as technical data management, ammunition packaging, battlefield robotic ammunition supply system, and spark the initial logistics research and development program. [Ref. 50: p. 16]

V. LIFE-CYCLE COST MODEL IN ACQUISITION PROCESS

Traditionally, military system had a tend only to emphasize the quality (effectiveness) and initial acquisition cost rather than total life-cycle cost [Ref. 51: pp. 39-44]. The ROK Army now has to prepare cost trade-off studies, operate under rigid change control procedures, comply with cost and schedule control system criteria, develop Life-Cycle Cost estimates, conduct risk analysis and track selected performance parameters, and most recently prepare to live with Design-to-Cost as a measure of engineering design effectiveness. For the past couple of years, we have been asked to provide ILS for new system acquisition. Therefore, the logisticians always have to have one eye on the ongoing program and the other on the future [Ref. 52: p. 15].

A. LOGISTICS IN THE SYSTEM LIFE CYCLE

In the military sense, logistics is concerned with the various aspects of maintenance and system/product support, particularly from the point in time when systems are in operational use. Logistics support should be a major consideration in the establishment of system requirements, in the development of design criteria, and in the evaluation of alternatives leading to the selection of a firm design configuration. The object is to develop a system that will fulfill its mission at the lowest overall life-cycle cost. [Ref. 28: pp. 1-2]

Systems and products have become more complex as technology advances, and logistics requirements have increased in general. Not only have the costs associated with system/

product acquisition increased significantly in the past decade, but the costs of logistic support have also been increasing at an alarming rate. At the same time, the current economic dilemma of decreasing budgets combined with upward inflationary trends result in less money available for the acquisition of new systems and/or for the maintenance and support of those items already in use.

In view of these trends, one of the greatest challenges facing industry, business, government agencies, and the general consumer of products and services today is the growing need for more effective and efficient management of our resources. The requirement to increase overall productivity in a resource-constrained environment has placed emphasis on all aspects of the system/product life cycle, and logistics has assumed a major role comparable to research, design, production, and system performance during operational use. The need to address total system life-cycle cost (in lieu of acquisition cost only) is evident, and experience has shown that logistic support is a major contributor to life-cycle cost. Further, experience has indicated that a great deal of the impact on the projected life-cycle cost for a given system or product stems from decisions made during the early phases of advance system planning and conceptual design. Decisions at this point have a major impact on activities and operations in all subsequent phases of the life cycle. Given the 'cause-and-effect' relationships and the fact that logistics costs may assume major proportions, it is essential that logistic support be considered (as a part of the decision-making process) at the early stages of system/product planning and design. [Ref. 28: pp. 5-6]

In essence, logistics, which includes the integration of many activities and elements, has become significant in each phase of the life cycle. Logistics requirements must be initially planned, and subsequently integrated into the system design process. The ultimate objective is to develop and produce a system design incorporating the necessary logistic support capability in an effective and efficient manner.

Logistics in the context of the system life cycle involves planning, analysis and design, testing, production, distribution, and the sustaining support of a system (or product) throughout the consumer "Use Period". With the advent of new technologies and the increasing complexities of system today, combined with limited resources and reduced budgets, it is essential that all facets of a system must be addressed in each phase of the life cycle and dealt with on an integrated basis.

The major facets of logistics as related to various program phases are highlighted as follows:

1. Identification of need (user).
2. Advance planning and conceptual design.
3. Advance development and preliminary system design (validation).
4. Detail design and development (full-scale development).
5. Production and/or construction.
6. System use and life-cycle support (user).
7. System retirement. [Ref. 28: pp. 3-8]

The functions involved with the system life cycle are closely related to logistic support. Figure 5.1 illustrates the system development process and conveys the major interfaces between prime mission equipment and logistics support. A step-by-step analysis depicted in Figure 5.1 is as: [Ref. 28: p. 9]

1. Given a specific need, system operational characteristics, mission profiles, development, utilization, effectiveness figures of merit, maintenance constraints, and environmental requirements are defined. Effectiveness figures of merit may include factors for cost effectiveness, availability, dependability, reliability, and so on. Using this

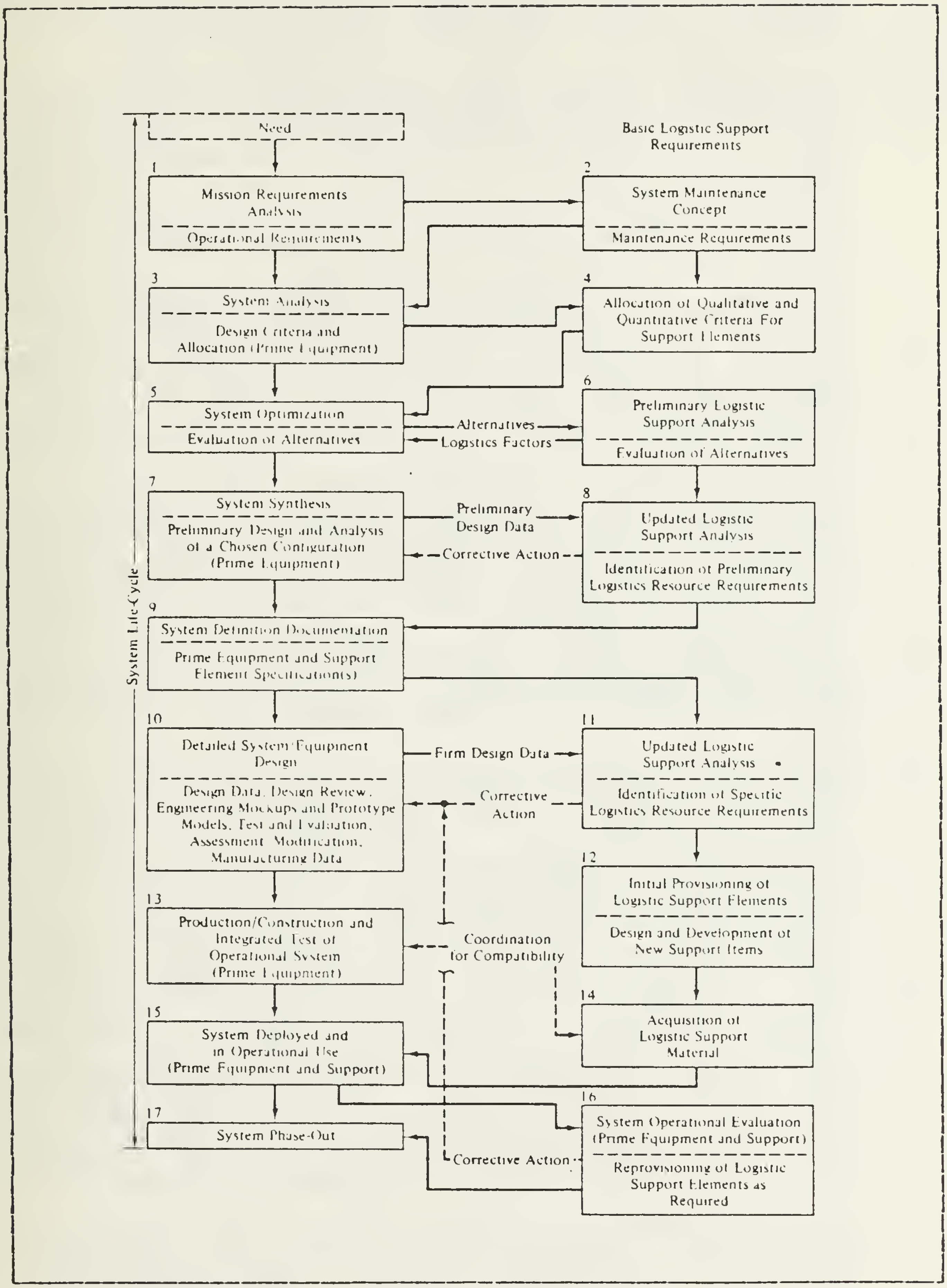
Need
Basic Logistic Support Requirements
1
Mission Requirements Analysis
Operational Requirements
2
System Maintenance Concept
Maintenance Requirements
3
System Analysis
Design Criteria and Allocation (Prime Equipment)
4
Allocation of Qualitative and Quantitative Criteria For Support Elements
5
System Optimization
Evaluation of Alternatives
Alternatives
Logistics Factors
6
Preliminary Logistic Support Analysis
Evaluation of Alternatives
7
System Synthesis
Preliminary Design and Analysis of a Chosen Configuration (Prime Equipment)
Preliminary Design Data
Corrective Action
8
Updated Logistic Support Analysis
Identification of Preliminary Logistics Resource Requirements
System Life-Cycle
9
System Definition Documentation
Prime Equipment and Support Element Specification(s)
10
Detailed System/Equipment Design
Design Data, Design Review, Engineering Mockups and Prototype Models, Test and Evaluation, Assessment Modification, Manufacturing Data
Firm Design Data
Corrective Action
11
Updated Logistic Support Analysis
Identification of Specific Logistics Resource Requirements
12
Initial Provisioning of Logistic Support Elements
Design and Development of New Support Items
13
Production/Construction and Integrated Test of Operational System (Prime Equipment)
Coordination for Compatibility
14
Acquisition of Logistic Support Material
15
System Deployed and in Operational Use (Prime Equipment and Support)
16
System Operational Evaluation (Prime Equipment and Support)
Reprovisioning of Logistic Support Elements as Required
17
System Phase-Out
Corrective Action

Figure 5.1 System Life Cycle and Logistics Interfaces.

information, the system maintenance concept is defined. Operational requirements and the maintenance concept are the basic determinants of logistic support resources (Figure 5.1, blocks 1 and 2).

2. Major operational, test, production, and support functions are identified, and qualitative and quantitative requirements for the system are allocated as design criteria (or constraints) for significant indenture levels of the prime equipment as well as applicable elements of support (i.e., test and support equipment, facilities, etc.). Those requirements that include logistics factors also form boundaries for design (Figure 5.1, blocks 3 and 4).

3. Within the boundaries established by the design criteria, alternative prime mission equipment and support configurations are evaluated through tradeoff studies, and a preferred approach is selected. For each alternative, a preliminary logistic support analysis is accomplished to determine the anticipated required resource associated with that alternative. Through numerous trade study iterations, a chosen prime mission equipment configuration and support policy are identified (Figure 5.1, blocks 5 and 6).

4. The chosen prime mission equipment configuration is evaluated through a logistic support analysis effort which leads to a gross identification of logistics resources. The system configuration (prime mission equipment and support elements) is reviewed in terms of its expected overall effectiveness and compliance with the initially specified qualitative and quantitative requirements (i.e., its capability to cost-effectively satisfy the statement of need). The ultimate output leads to the generation of a system specification (and lower-level specifications) formed the basis for detail design (Figure 5.1, blocks 7 through 9).

5. During the design process, direct assistance is provided to design engineering personnel in areas such as reliability, maintainability, supportability, and human factors. These tasks include the interpretation of criteria; accomplishment of special studies; participation in the selection of equipment and suppliers; accomplishment of predictions (reliability and maintainability); participation in progressive formal and informal design reviews; and participation in the test and evaluation of engineering models and prototype equipment. An in-depth logistic support analysis, based on released design data, results in the identification of specific support requirements in terms of tools, test and support equipment, spare/repair parts, personnel quantities and skills, training requirements, technical data, facilities, transportation, packaging, and handling requirements. The logistic support analysis at this stage provides (a) an assessment of the prime equipment design for supportability and potential cost/system effectiveness, and (b) a basis for the provisioning and acquisition of specific support items (Figure 5.1, blocks 10 through 12).

6. Prime mission equipment items are produced, constructed, tested, and deployed or phased into full-scale operational use. Logistic support elements are acquired, tested, and phased into

> operation on an as-needed basis. Throughout the operational life cycle of the system, logistics data are collected to provide (a) an assessment of system cost effectiveness and an early identification of operating or maintenance problems, and (b) a basis for the reprovisioning of support items at selected times during the life cycle (Figure 5.1, blocks 13 through 16). [Ref. 28: pp. 7-10]

B. ACQUISITION PROCESS AND COST-EFFECTIVENESS ANALYSIS

1. Acquisition Strategy in ROK

Acquisition means the acquiring by contract with appropriate funds of supplies (including construction) by and for the use of the Government through purchase, lease, or barter, whether the supplies or services are already in existence or must be created, developed, demonstrated, and evaluated. Acquisition begins at the point when agency needs are established and includes the description of requirements to satisfy agency needs, solicitation and selection of sources, award of contracts, contract financing, contract performance, contract administration, and those technical and management functions directly related to the process of fulfilling agency needs by contract. [Ref. 53: p. 19.0]

Small countries are not normally capable of satisfying all their military needs through internal manufacturing due to a lack of domestic resources. The required combination of large amounts of capital, raw materials, advanced technology, and skilled manpower needed for the establishment and operation of defense-oriented industries can rarely be found in small countries [Ref. 55: p. 8]. Even if these were present, learning curves argue against small production levels.

The acquisition strategy of weapon system can be divided as follows:

1. Self-production.

2. Co-production
3. Direct purchase.
4. Cooperative production.
5. Military aid.
6. Mixed type.

In the concrete, self-production comprises pure R&D and production, copy production of the existing system, and modification production. Co-production includes technology import, license, royalty, and hardware import type. Direct purchase can be classified by purchase route and condition. Cooperative production involves joint production, joint venture, and multi-national industry. Military aid is divided into grant-aid and foreign military sale (FMS). In developing countries whose industry and economic power are behind, self-production may not be the best alternative. [Ref. 51: p. 124]

What is the best strategy? It depends on the situation. Under the enemy's threat and time constraint for self-production, direct purchase may be the best way. Also, co-production may be a better strategy because of limited technology to produce high-level systems. Sometimes, joint production was taken by allied nations to improve economical benefits and strengthen the allied relationship.

Self-production of weapon system must be the ultimate goal for ROK self-defense endeavor. ROK has concentrated on self-production since 1976, even if it has some disadvantages such as more R&D and production cost, more time, and higher failure probability during R&D. But, it has advantages such as techno-economic effects to the other industries, enhancement of people's morale, and inspiration of self-defense spirit. Therefore, this thesis focuses on the required decision-making during the acquisition cycle when ROK selects the self-production strategy. [Ref. 51: pp. 105-126]

2. Cost and Price in the Acquisition Process

The program acquisition cycle requires cost estimating for each program phase in order to maintain total program cost visibility. This cost visibility is required to ensure adequate control as well as the basis for decisions affecting the continuation and accomplishment of the program objectives. [Ref. 56: p. 1]

The phases of the acquisition process consist of evaluation and reconciliation of needs, exploration of alternative systems, competitive demonstrations, full scale development, test and evaluation, production, and deployment and operation. Since acquisition costing varies among organizations, an attempt to describe fully and precisely costing in the acquisition process throughout the Government would be too detailed. It is sufficient to present an overview of costing and pricing functions in the respective phases of the acquisition process and to differentiate these functions with respect to their uses in planning, budgeting and contracting. [Ref. 54: p. 3]

The conceptual phase of the acquisition cycle identifies the needs and goals for a new system according to the activity's mission and evaluates the means to satisfy these mission needs. Hence, the basic need for a new system must be identified and defined in terms of the mission need. Current acquisition guidance stresses that the mission need statement should not be expressed in terms of needed equipment, but, instead, in terms of basic performance requirements. Therefore, each activity should investigate and compare the cost, effectiveness, and risks of alternative approaches to provide the bases for selection of one or more systems which warrant further development to satisfy a valid element need.

The demonstration and validation phase of the acquisition cycle begins once this need has been established. In this phase, the major program characteristics of the system such as technical, schedule, and cost requirements are refined and validated through extensive study, analysis, test, and evaluations. The objective is to validate the choice of viable alternative systems or critical subsystems and to provide a basis for selection of a system for full scale development according to mission needs.

In the full-scale development phase and initial production the mission need is again reaffirmed and the validation results reviewed. Upon completion, selection of a system or equipment for full-scale engineering development and initial production is approved, the principal items necessary for support are designed, and a minimum number of models are either constructed or simulated, tested, and evaluated to provide actual performance data. Based on results obtained in this phase, the system is defined in terms of technical performance, schedule, and cost. A decision is then made on whether or not to proceed with full scale production. Once the production phase is initiated, the system is produced for operational use along with any necessary supplies, training and support equipment. [Ref. 54: p. 4]

It should be apparent that the acquisition process is a series of sequential steps. There is a steady progression from need determination to receipt and use of the purchase equipment or service. Correspondingly, there is a series of reviews, redeterminations, and adjustments to accommodate to changes in need or resource availability. The critical dependence of major systems acquisition planning on innovative and reliable cost estimating methodologies is recognized in today's acquisition management policy.

Agencies acquiring major systems have to maintain a capability to predict, review, assess, negotiate and monitor cost in all phases of the life cycle. Continuous cost predictions and subsequent reassessment must be considered by the agency head at key decision points. On the basis of estimated life-cycle costs, appropriate trade-offs can be made among cost, schedules, and performance.

The acquisition of a major and complex system is a series of iterations of the process shown in Figure 5.2. This illustrated process is used by US Federal Government. The validation, full-scale development, and production phases are each acquisitions in their own right. The same actions are taken during each phase a costing and review function is added between phases.

The acquisition process spans a number of traditional functions - planning, budgeting, contracting, and contract administration. Each of these functions contains a distinct area of specialization. The traditional functional span in the acquisition process has produced a problem in definition. The costing effort and techniques in the planning process differ from those used in the contracting process. Therefore, we have defined the following terms for use in this thesis. [Ref. 54: pp. 5-8]

1. Acquisition Costing - The total process of developing, prepareing, and monitoring a 'cost to the Government' for goods or services. It encompasses the activities of cost estimating, cost analysis and price analysis.
2. Cost Estimating - The development of an expected value of the total 'total to the Government' without the knowledge or benefit of a definite bid for the specific goods or services.
3. Contract Cost Analysis - The review and evaluation of a contractor's cost and pricing data to determine the probable cost to the contractor to supply the goods or services.
4. Price Analysis - The review, in varying detail, of a prospective price, without evaluation of the separate cost elements of that price.

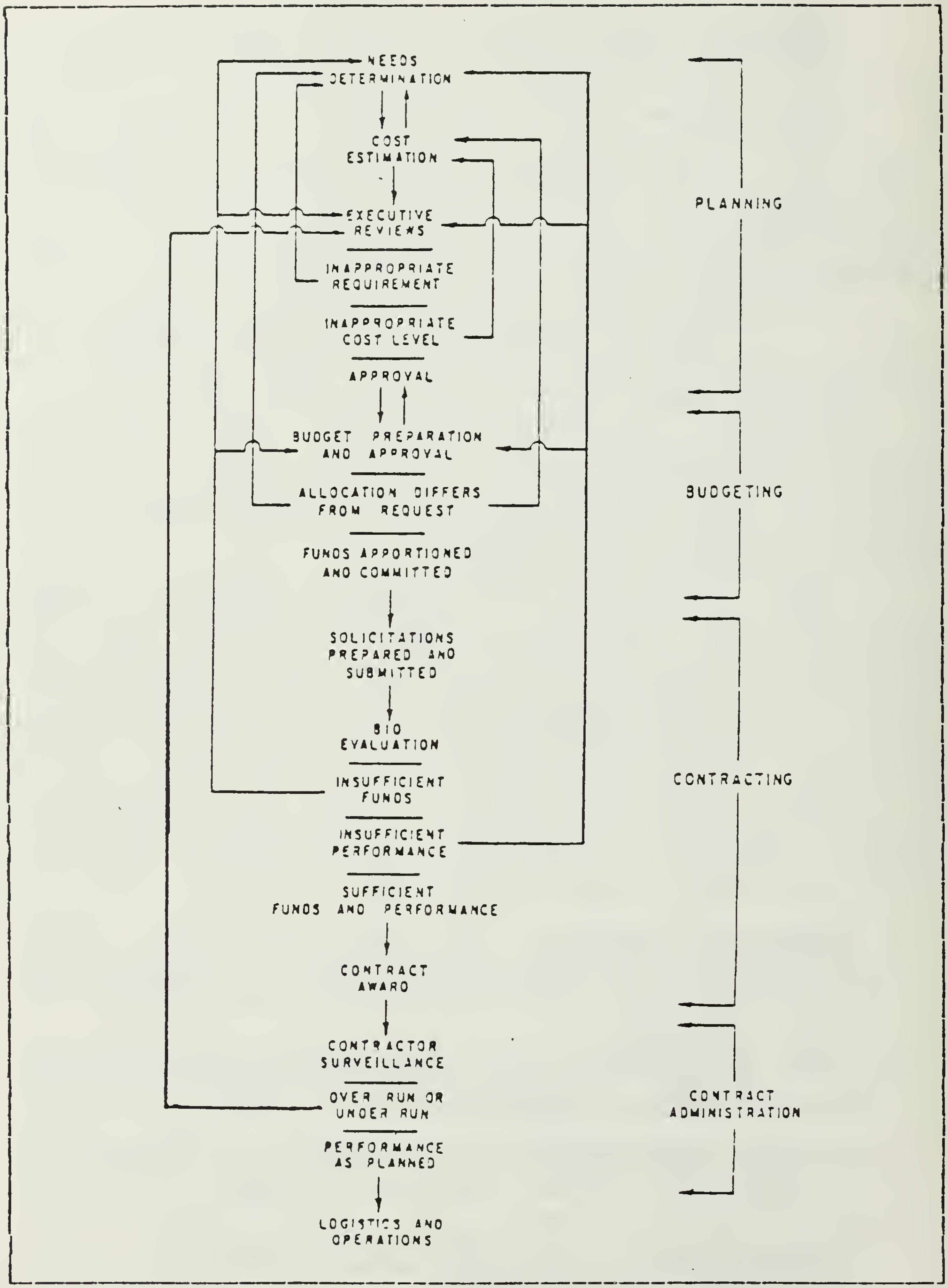

Figure 5.2 Costing/Pricing in Federal Acquisition Process.

3. Cost-Effectiveness(CE) Model

a. Overview

The development of a system or product that is cost effective, within the constraints specified by operational and maintenance requirements, is a prime objective. Cost effectiveness relates to the measure of a system in terms of mission fulfillment (system effectiveness) and total life-cycle cost. Cost effectiveness, which is similar to the standard cost-benefit analysis employed for decision-making purposes in many industrial and business applications, can be expressed in various terms (i.e., one or more figures of merit), depending on the specific mission or system parameters that one wishes to measure. The prime ingredients of cost effectiveness are illustrated in Figure 5.3. [Ref. 28: pp. 21-22]

Cost-effectiveness analysis provides a conceptual framework and methodology for systematic investigation of alternatives. It enables the user to choose the preferred alternative out of many approaches. By applying the analysis procedure, it becomes possible to select the optimal alternative for achievement of the goals defined within the allowed constraint boundaries such as budget.

Of these two elements, cost is easier to measure and handle because it can be expressed by a single, monetary value. Effectiveness is harder to deal with. It can be presented both in terms of certain parameters which have clear-cut numerical representations and others which are not readily quantifiable. This section concentrates on quantifiable effectiveness measures that can be defines by mathematical formulas and expressions, such as Operational Availability.

It is recognized that political, social, and other non-quantifiable aspects are of great importance in

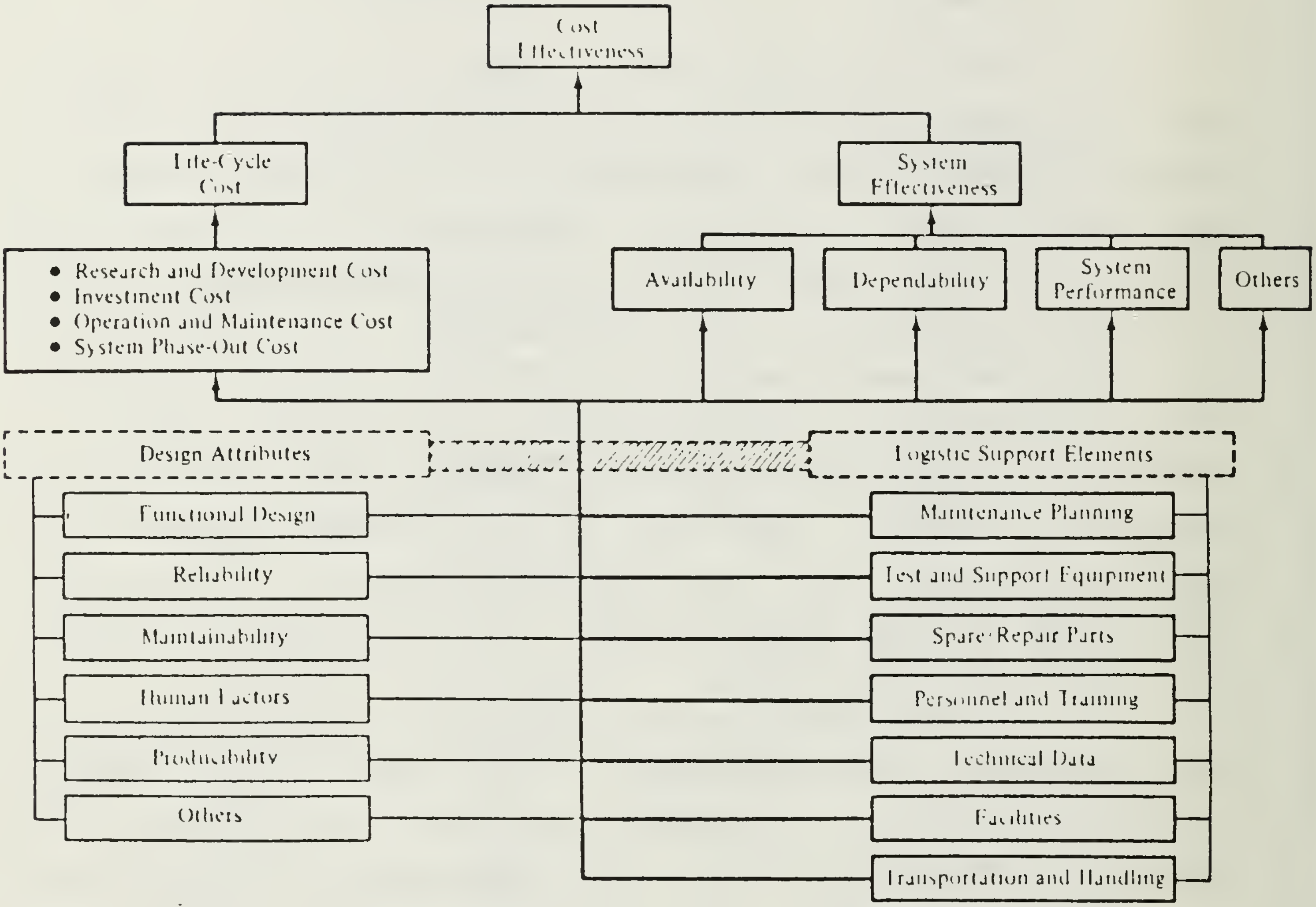

Figure 5.3 Prime Cost-Effectiveness Elements.

any decision process [Ref. 55: pp. 22-23]. However, their treatment is considered to be of such complexity as to be beyond the scope of this thesis. The following section describes cost and effectiveness terms with regard to a procurement decision process.

b. System Effectiveness

System effectiveness is often expressed as one or more figures of merit representing the extent to which the system is able to perform the intended function. The figures of merit used may vary considerably depending on the type of system and its mission requirements, and should consider the following: [Ref. 28: p. 20]

1. System performance parameters, such as the capacity of a power plant, range or weight of an airplane, destructive capability of a weapon, quantity of letters processed through a postal system, amount of cargo delivered by a transportation system, and the accuracy of a radar capability.
2. Availability, or the measure of the degree a system is in the operable and committable state at the start of a mission when the mission is called for at an unknown random point in time. This is often called "operational readiness." Availability is a function of operating time (reliability) and downtime (maintainability/supportability).
3. Dependability, or the measure of the system operating condition at one or more points during the mission, given the system condition at the start of the mission (i.e., availability). Dependability is a function of operating time (reliability) and downtime (maintainability/supportability).

A combination of the foregoing considerations (measures) represents the system effectiveness aspect of total cost effectiveness. By inspection, one can see that logistics impacts the various elements of system effectiveness to a significant degree, particularly in the areas of availability and dependability. System operation is highly dependent on support equipment (handling equipment), operating personnel, data, and facilities. Maintenance and system downtime are based on the availability of test and support equipment, spare/repair parts, maintenance personnel, data, and facilities. The effect of the type and quantity of logistic support is measured through the parameters of system effectiveness. [Ref. 28: p. 21]

In recent years, a variety of models and definitions of system effectiveness have been developed using different concepts of effectiveness. These models base their measures upon combinations of terms such as mission reliability, operational readiness, availability, design adequacy, capability and utilization. Among all these terms, availability is the one of the most commonly used, and will be emphasized in this part because of its logistical importance.

Although several types of availability are defined (Inherent, Achieved, and Operational), the one considered to be important for effectiveness evaluation purposes during the use period of the system is Operational Availability (Ao). It is more closely related to the actual operational environment than the other two measures and is affected more by user decisions than the others. It is defined as: [Ref. 55: pp. 23-24]

$$A_o = \frac{MTBM}{MTBM + MDT}$$

where, MTBT = Mean-Time Between Maintenance Actions
MDT = Mean Down Time

Availability concerns itself with the operating-time (Reliability) and down-time (Maintainability), both being system design characteristics. In dealing with electronic systems, the failure rate (λ) can often be considered as constant through the use period. It enables one to fit a Poisson distribution to the number of failures which occur during a given time interval in a system. As a consequence, the times to failure can be described by an exponential distribution. Reliability is defined to be the probability that the system survives over a given time interval. It is therefore a function of time (t) and can be described mathematically by the formula:

$$R(t) = e^{-\lambda t} = e^{-t/MTBF}$$

where, MTBF = Mean Time Between Failures
λ = Failure Rate

The design for maintainability directly affects many of the resources needed for performance of the support activities during the life cycle. These play a major role in determination of life-cycle cost, accounting for more than the procurement cost. In particular, MDT includes all time elements needed to retain the system or restore it to an operational condition (preventive and corrective maintenance) as well as administrative and logistic times. The user should minimize those aspects of these time elements within his control if he expects to maximize the operational availability.

Experience has shown that reliability and maintainability predictions provided by the manufacturer tend to be over-optimistic. The value of the MTBF, even if proven in a demonstration test, usually turns out to be several times lower when the system is placed in the actual operational environment. In addition, actual repair times obtained in the field, exceed up to several times those of a maintainability demonstration. These facts should be seriously considered when using reliability and maintainability data for effectiveness and cost predictions, and when applying cost-effectiveness analysis. [Ref. 55: pp. 26-27]

c. Life-Cycle Cost

Life-Cycle Cost includes the cost associated with all system activities pertaining to research and development, design, test and evaluation, production, construction, product distribution, system operation, sustaining maintenance and logistic support, and system retirement and disposal [Ref. 28: p. 67]. The development of the LCC for use in system evaluation was motivated by the fact that the major part of user budgets are spent on operations and support activities [Ref. 55: p. 27].

LCC is of particular significance in the definition of logistic support requirement, since the costs associated with the system support are increasing at an alarming rate and often exceed the cost of system acquisition [Ref. 28: p. 68]. The main motivation behind the LCC method is to make trade-offs possible which enable savings to be made during the use period by increasing expenditures during the acquisition period, and thus to lower the total cost of the system.

In developing life-cycle cost figures and computing total cost, several steps are required. These will be suggested more thoroughly in the following section.

d. Cost-Effectiveness Trade-offs

Any system is a result of trade-offs and compromises performed during different phases of its development and use. These trade-offs may be divided into two major categories.

The first category, system effectiveness trade-offs, includes those pertaining to various characteristics of the system, such as reliability, maintainability, and availability. It is possible to produce a highly reliable (low failure rate) or a highly maintainable system (quickly restored), but the same operational availability may also be achieved by trade-offs between these two. The most suitable balance between them may be based on the relative costs.

Another category includes trade-offs among cost categories. Higher investments during the R&D phase may reduce production costs, and both may increase or decrease expenditures during the use period of the system (O&S costs).

These two major categories usually do not occur independently of one another. Decisions with regard to module size, repair policies (maintenance level and repair vs. discard), types of maintenance (corrective vs. preventive), level of automation, human factors (man vs. machine), and packaging influence costs as well as system performance. As a consequence, the composite or cost-effectiveness balance should be sought which allows the user to have the best system possible subject to technological and budgetary constraints. In cases where equipment is bought 'off the shelf,' the spectrum of trade-offs is limited because many design features are already built into the system. [Ref. 55: pp. 30-31]

C. APPLICATIONS OF LCC MODEL

When ROK Army considers the development of weapon system, it must decide between the appropriate alternatives. In this case, cost estimating plays an important role in the analysis of alternatives. This section describes the basic elements and general basic concepts to all cost estimates, costing method and a common frame work for life-cycle cost estimates. Finally, this thesis suggests a sample example for acquisition decision.

1. Basic Elements to all Cost Estimates

At certain milestones throughout the acquisition process, a decision is to be made based on the probable life-cycle cost of acquisition (e.g., between alternative systems, whether to start production, etc.). This decision must be made based on the amount of data available to the analyst at the moment [Ref. 54: p. 12]. The critical dependence of major systems acquisition planning on cost estimating methodologies can be recognized in today's acquisition management policy in ROK military. To do cost estimating successfully, organization, data and analysts are essential factors. We can make cost estimating and analysis organization immediately, but it takes long time to collect available data and to train good analysts.

One of the most vitally important steps in the cost estimating is to assemble an appropriate data base [Ref. 57: p. 130]. The US government has been collecting cost and program data on weapon and support systems for many years - sometimes in detail, sometimes in highly aggregated form. Consequently, it is surprising that the right data seldom seem to be available when an estimating job is required [Ref. 58: p. 11]. Since the data problem is fundamental, the ROK military should establish the effective data base system. We note that of the total time involved in the process of developing cost estimating, more effort is typically devoted to the assembly of a consistent data base than anything else. ROK military also devotes a considerable effort to making good analysts. What a cost analyst is: [Ref. 59: p. 1.1]

1. A cost analyst is an individual qualified through formal training and work experiences to provide to management the most credible and realistic cost estimates.
2. A cost analyst is broad-gauged and management oriented, which is to say he is interested in anticipating and identifing issues of management import.
3. A cost analyst is a multidisciplined professional who employs operations research, engineering and econometric techniques to prepare, evaluate and validate cost estimates.
4. A cost analyst is interested in assuring that the overall cost to the Government of materiel systems, forces, units and activities is presented in ways which yield cost realism and thereby improve the allocation and management of Army resources at all levels.
5. A cost analyst is product oriented, conducting cost research and analysis, and producing technical papers and reports containing findings and, where appropriate, recommendations.

In conclusion, the effective and efficient organization, appropriate data and skillful analysts are essential to make the best analysis on acquisition alternatives in the ROK military.

2. General Basic Concepts to all Cost Estimates

a. Inflation and Discounting

Inflation and discounting can both be used to modify future costs to present costs [Ref. 55: p. 186]. Inflation is the term applied to upward movement of price levels overtime. Discounting is a technique for converting various cash flows (cost streams) to economically comparable amounts at a common point in time, considering the time value of money [Ref. 59: pp. 5.1-5.2]. Various cost estimates can be presented either in "current dollars" or in "constant dollars", with the first preferred [Ref. 55: p. 186].

The effect of inflation and discounting can be combined into an adjustment factor for each year's cost by following formula: [Ref. 60: p. 121]

$$AF = \left(\frac{1 + i}{1 + d} \right)^n$$

where, AF = adjustment factor
i = average inflation rate/yr
d = average discount rate/yr[39]

Usually, military organizations do not have a predictable stream of revenues. Therefore, the present value method can be modified into a discounting method [Ref. 55: p. 187].

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[39] The current discount rate specificied by US Office of the Secretary of Defense is 10 percent.

b. Sunk Costs and Inherited Assets

Sunk cost is the summation of all past expenditures or irrevocably committed funds related to a given cost estimates. So, sunk costs are generally not relevant to decision-making as they reflect previous choices rather than current choices, but sunk costs can become relevant in cases where they represent assets that would be employed in lieu of new assets in some cost-effectiveness analysis.

The use of assets already in the military inventory (inherited assets) requires careful evaluation during the conduct of cost analysis. Each inherited asset must be evaluated on its own merits and in terms of whether its use in connection with the system or force being costed will cause future expense to the military. If it does cause a future cost, that expense must be included in some cost element in the estimate. If it does not, it should be treated as sunk cost. [Ref. 59: p. 5.1]

c. Range versus Point Estimates

The use of a point estimate does not reflect the uncertainty associated with the estimate. It also implies that it is a precise cost. For these reasons, a range of cost should be provided based on the inherent cost estimating uncertainty. The level at which the ranges can be provided is dependent upon the level at which the costs are estimated. Within the limitations imposed by the data base and cost estimating approach employed, ranges should be presented at the highest aggregate level.

In addition, an analysis should be made of the sensitivity of projected costs to all critical assumptions. This should include factors such as the impact of changes in performance characteristics, changes in configuration to meet performance requirements, schedule alterations and alternative production processes. Therefore, a cost sensitivity analysis should be provided in terms of high and low estimate assumptions. [Ref. 61: p. 3.0]

d. Treatment of Uncertainty

Uncertainties in estimates of resource requirements for future systems arise from many sources. We can consider two categories of uncertainty: requirements uncertainty and cost-estimating uncertainty. Requirement uncertainty refers to variations in cost estimates stemming from changes in the configuration of the system being costed. We note that uncertainty about requirement comprises 70 to 80 percent of total estimate uncertainty in the US military. [Ref. 62: p. 1]

Cost-estimating uncertainty refers to variations in cost estimates of a system for which the configuration is essentially fixed. It can arise from a variety of causes. In an overall context, the following might be singled out: errors in data, errors in cost-estimating relationships, and extrapolation errors. [Ref. 58: pp. 131-133]

Treatment of uncertainty in cost analysis has been studied in terms of various methods: cost sensitivity analysis, variance analysis, and Monte Carlo techniques[40] [Ref. 58: pp. 133-154].

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[40] [Ref. 58] describes cost sensitivity analysis, variance analysis, and Monte Carlo method in details.

e. Learning Curve

For many years the aerospace industry in the US has made use of what variously have been called "learning", "progress", "improvement", or "experience" curves to predict reductions in cost as the number of items produced increases. Thesedays, the learning process is a phenomenon that prevails in many industries in the world; its existence has been verified by empirical data and controlled tests. Although there are several hypotheses on the exact manner in which the learning or cost reduction can occur, the basis of learning-curve theory is that each time the total quantity of items produced doubles, the cost per item is reduced to a constant percentage of its previous cost. [Ref. 58: p. 93]

Therefore, we should draw an cumulative average learning curve rate or a unit learning curve rate which can be applied to the increase in production efficiency, in so far as costs subject to the learning function are concerned. This rate approximates an "80% curve" which means that when quantities of production are doubled on item, cumulative average man-hours should be reduced 20% [Ref. 63: p. 9].

The relationship between cost and quantity may be represented by a power (log-linear) equation of the form [Ref. 58: pp. 96-97].

$$Y = AX^{b}$$

where, a unit learning curve (a cumulative average)

A = the cost of the first unit produced (the same)
b = the slope of the learning curve (the same)
Y = the cost of the Xth unit (the average cost of the X units)

3. Cost Estimating Method

A cost estimate is a judgement or opinion regarding the cost of an object, commodity, or service [Ref. 58: p. 1]. In the early planning and budgeting stages of now acquisitions, no bid or proposal is usually available for analysis, hence, cost estimating must normally be used [Ref. 54: p. 13].

The challenge to cost analysts concerned with military hardware is to project from the known to the unknown, to use experience on existing equipment to predict the cost of advanced weapon systems: Korean indigenous missiles, aircrafts, tanks and APCs. The techniques used for estimating hardware cost range from intuition at one extreme to a detailed application of labor and material cost standards at the other [Ref. 58: pp. 1-2]. The techniques of cost estimating may be grouped into four generic categories: analogy, expert opinion, parametric and engineering estimates [Ref. 54: p. 13].

a. Analogy

This method is based on the premise that the current acquisition is identical or very similar to previous acquisitions. A comparison and analysis is made of any similarities at either the component or parts level. To make the comparison the costs associated with the previous acquisition must be verified and justified, then adjusted for inflation by using cost indices. The analyst should review the level of technology employed and reflect these in his estimate. Adjustments should be made for any changes in specifications, quantities, or delivery schedules.

Estimating by analogy is used primarily when there are very few similar systems. The data must be carefully classified by type of article to be acquired. This classifying must be sufficiently detailed to allow careful comparison of both total systems and various subsystems. Since these subsystem components could be in totally unrelated systems (e.g., a power source for an airborne radar system could be identical to one required for a ground radio jammer), it is necessary, or at least desirable, to classify by each separate logical subsystem level. Data sources should include a history of all recent acquisitions, catalogs, and federal supply schedules and should not be limited to acquisitions of the department or agency seeking the information. [Ref. 54: pp. 13-14]

The major drawback to estimating by analogy is that it is essentially a judgement process and, as a consequence, requires considerable experience and expertise to be done successfully. However, for the military cost analyst, analogy can be useful for a rough check of an estimate.

Because a private concern generally has information only on its own products, much of the estimating in industry is based on analogy, particularly when a firm is venturing into a new area. For example, in the 1950s, the US Douglas aircraft company(Mcdonnel-Douglas) made a good estimate on the Thor intermediate range ballistic missile by comparing Thor with the DC-4 transport airplane. [Ref. 58: pp. 6-7]

b. Expert Opinion

Another technique of estimating is the application of expert opinion. In its simplest form, this approach to estimating consists of an individual providing a probable cost based on personal knowledge of similar items or the amount of work needed to perform a task. More often a modified Delphi method[41] is employed, where a panel of experts each provide their rationale for an expected cost and argue their respective viewpoints until a general consensus is achieved. The major drawback to this technique is the inability to find an expert or to support the results with any quantitative analysis or data. Expert opinion relies on personal estimates using such concepts as "more than" and "less than" rather than factual knowledge of detailed work inputs and dollar costs. This type of estimating technique results in a broad estimate or round order of magnitude employed in the earliest stages of the acquisition process when very little data is available. [Ref. 54: p. 14]

c. Industrial Engineering Procedure

Estimating by industrial engineering procedures can be broadly defined as an examination of separate segments of work at a low level of detail and a synthesis of the many detailed estimates into a total [Ref. 58: p. 2]. So, the total cost of an hardware is the sum of the costs of all of its elements. These elements include material, labor, indirect costs, overhead and profit. To use engineering detail, it is necessary to be able to estimate the required work input and material for each subtask. This information is often arrayed in the form of a work breakdown structure. Once all the material and labor requirements have been inserted, each requirement is priced and summed to arrive at the total cost for a job. Thus, small percentage errors in each of the detailed estimates can result in large absolute errors in the total. [Ref. 54: p. 16]

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[41] Delphi method is the procedure that the judgements are made independently and anonymously, pooled, summarized, and then fed back to the judges for another round of opinion. More detail is in [Ref. 51].

Industrial engineering estimating procedures require considerably more personnel and data than are likely to be available to government agencies under any foreseeable conditions [Ref. 58: p. 5]. In a complicated hardware case, they take much time and are costly to both contractor and government during a period of limited funds. Moreover, for many purposes they have been found to be less accurate than estimates made statistically [Ref. 58: p. 5]. However, engineering methods are most appropriate when the military has responsibility for design and preparation of detailed specifications [Ref. 54: p. 16].

d. Statistical Procedure (Parametric)

In the statistical approach, estimating relationships that use explanatory variables such as weight, speed, power, frequency, and thrust are relied on to predict cost at a higher level of aggregation than the industrial engineering [Ref. 58: p. 2].

The relationship that a variable has to cost is called a cost estimating relationship(CER). The CER is often expressed as a mathematical equation(linear or nonlinear) that allows the estimator to project the cost of an item with a value of the explanatory variable that differs from those currently available.

Data requirements for parametric estimating are extensive. The cost estimator must recognize which variables have a valid relationship to cost. Once developed, CER's must be continually updated and refined as new data is obtained. The new data adds to the data base allowing the CER to become more useful. It is evident that CER's may be constrained by the need for a suitable data base of similar systems. Although parametric analysis may be used through the acquisition cycle, it must be used extensively during the conceptual and validation phases.

Parametric costing is thought to be a more reliable method than expert opinion, and probably more reliable than analogous costing. The reason is most likely more a function of definition and use than fact. [Ref. 54: p. 15]

Although statistical procedures are preferable in most situations, there are circumstances when analogy or industrial engineering techniques are required because the data do not provide a systematic historical basis for estimating cost behavior on a combination [Ref. 58: p. 7].

In conclusion, in any situation the estimating procedure to be used should be determined by the data available, the purpose of the estimate, and, to an extent, by such other factors as the time available to make an estimate. The essential idea to be conveyed in this section is that, when properly applied, statistical procedures are varied and flexible enough to be useful in most situations that ROK military analysts are likely to encounter. Although no specified set of procedures can guarantee accuracy, decisions must be made: it is essential that they be based on the best possible information. The analyst must seek the approaches that will provide the best possible answers, given the basic information that is available. [Ref. 58 : p. 9]

4. A Common Framework for Life-Cycle Cost Estimates

So far, the general methods of estimating a new weapon system cost have been introduced. General conception of life-cycle cost described in the previous section. We need a complete, detailed and fully documented estimate of system life-cycle costs accomplished by the system proponent (weapon system project manager), but overall study is beyond the purpose of this thesis. This section describes general guidelines and procedures for a system life-cycle cost estimates.

a. A General Guide for LCC

In developing LCC figures, one of the first step is to construct a cost breakdown structure (CBS), a life-cycle CBS is an ordered breakdown of the components of LCC, which represent an accounting model for LCC estimates. Although a standard life-cycle CBS does not exist, many common elements are included in a lot of them. The first breakdown level includes usually four categories: Research and Development, Investment, Operations and Support, and Retirement and Disposal Cost [Ref. 55: p. 187]. A possible life-cycle CBS is illustrated in Figure 5.4 [Ref. 28: p. 68].

The second step is estimate each cost by category in the CBS. Cost analyst must consider the effects of inflation, learning curves, and any other factors that are likely to cause changes in cost, upward or downward. Cost estimates are derived from a combination of accounting records (historical data), project cost projections, supply proposals, and predictions.

A common framework for general cost estimates can be evolved under the following criteria: [Ref. 65: P. 2.0].

1. It must be compatible with both top-down and bottoms-up cost estimating approaches. The framework must not, by its composition, preclude use of either approach. It must be compatible with cost analysis policy and convention.
2. It must capture 100 percent of costs. It must be comprehensive but not necessarily detailed.
3. It must be manageable in size. Simplification in level of cost analysis detail is essential.

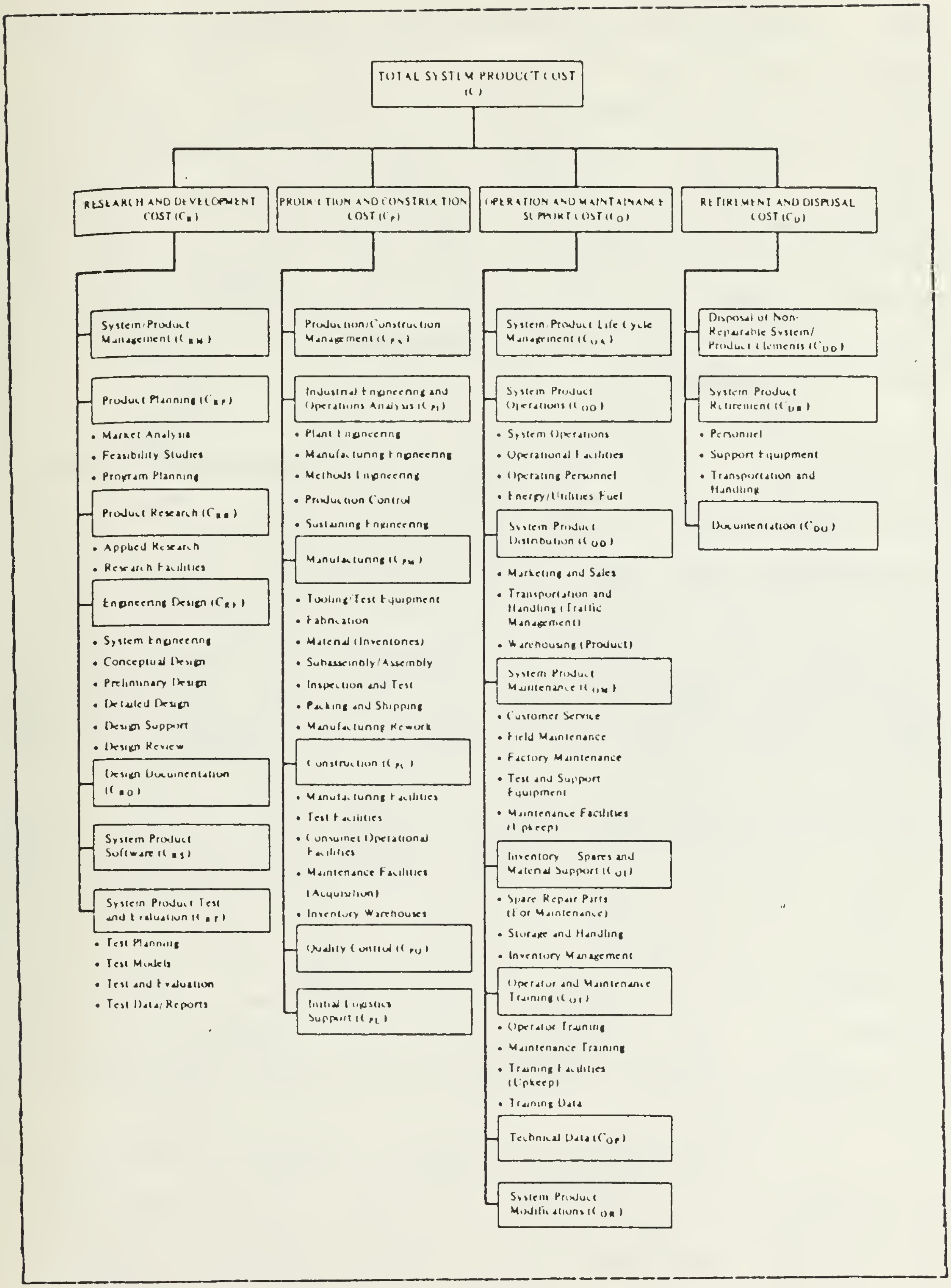
TOTAL SYSTEM PRODUCT COST (C)
RESEARCH AND DEVELOPMENT COST (C_R)
PRODUCTION AND CONSTRUCTION COST (C_P)
OPERATION AND MAINTAINANCE SUPPORT COST (C_O)
RETIREMENT AND DISPOSAL COST (C_D)
System/Product Management (C_{RM})
Product Planning (C_{RP})
• Market Analysis
• Feasibility Studies
• Program Planning
Product Research (C_{RR})
• Applied Research
• Research Facilities
Engineering Design (C_{RE})
• System Engineering
• Conceptual Design
• Preliminary Design
• Detailed Design
• Design Support
• Design Review
Design Documentation (C_{RD})
System Product Software (C_{RS})
System Product Test and Evaluation (C_{RT})
• Test Planning
• Test Models
• Test and Evaluation
• Test Data/Reports
Production/Construction Management (C_{PM})
Industrial Engineering and Operations Analysis (C_{PI})
• Plant Engineering
• Manufacturing Engineering
• Methods Engineering
• Production Control
• Sustaining Engineering
Manufacturing (C_{PM})
• Tooling/Test Equipment
• Fabrication
• Material (Inventories)
• Subassembly/Assembly
• Inspection and Test
• Packing and Shipping
• Manufacturing Rework
Construction (C_{PC})
• Manufacturing Facilities
• Test Facilities
• Consumer Operational Facilities
• Maintenance Facilities (Acquisition)
• Inventory Warehouses
Quality Control (C_{PQ})
Initial Logistics Support (C_{PL})
System/Product Life Cycle Management (C_{OA})
System Product Operations (C_{OO})
• System Operations
• Operational Facilities
• Operating Personnel
• Energy/Utilities Fuel
System Product Distribution (C_{OD})
• Marketing and Sales
• Transportation and Handling (Traffic Management)
• Warehousing (Product)
System Product Maintenance (C_{OM})
• Customer Service
• Field Maintenance
• Factory Maintenance
• Test and Support Equipment
• Maintenance Facilities (Upkeep)
Inventory — Spares and Material Support (C_{OI})
• Spare Repair Parts (For Maintenance)
• Storage and Handling
• Inventory Management
Operator and Maintenance Training (C_{OT})
• Operator Training
• Maintenance Training
• Training Facilities (Upkeep)
• Training Data
Technical Data (C_{OP})
System Product Modifications (C_{OR})
Disposal of Non-Repairable System/Product Elements (C_{DD})
System Product Retirement (C_{DR})
• Personnel
• Support Equipment
• Transportation and Handling
Documentation (C_{DO})

Figure 5.4 Cost Breakdown Structure (example).

There are a lot of weapon systems in the ROK Army. A weapon system can be broken down into the several specific system types: aircraft, missile, surface vehicle, electronic and ordnance system. Each specific system can also be broken down into several functional components: fire control, armament, peculiar support equipment, common support equipment, and so on. So, life-cycle cost estimate should be conducted in all functional components of each specific system. The life-cycle cost estimates for discussion of system in general is presented in Figure 5.6. [Ref. 65: p. 2.5]

The next step is to compute and to add each cost for each year in the system life cycle by general equations. The following section make explicit a common framework for cost computations. Individual first-level cost factors, estimated for each year in the life cycle in terms of the actual anticipated cost for that year (i.e., inflated cost), are totaled and projected in the context of a cost profile illustrated in Figure 5.7 [Ref. 28: p. 73]. This profile reflects future life-cycle budgetary requirements for the system.

The next step is to evaluate alternatives. Each alternative configuration is represented by a different cost profile, since cost-generating activities will vary from one instance to the next, reliability and maintainability factors will be different, and the specific logistic support requirements will be unique for each situation. Figure 5.5 reflects the cost profiles for three potential system configurations being considered for a single application. [Ref. 28: p. 68]

The comparison of various possible courses of action requires that the cost associated with alternatives in question be compared on an equivalent basis (i.e., the point in time when the decision is to be made, which is

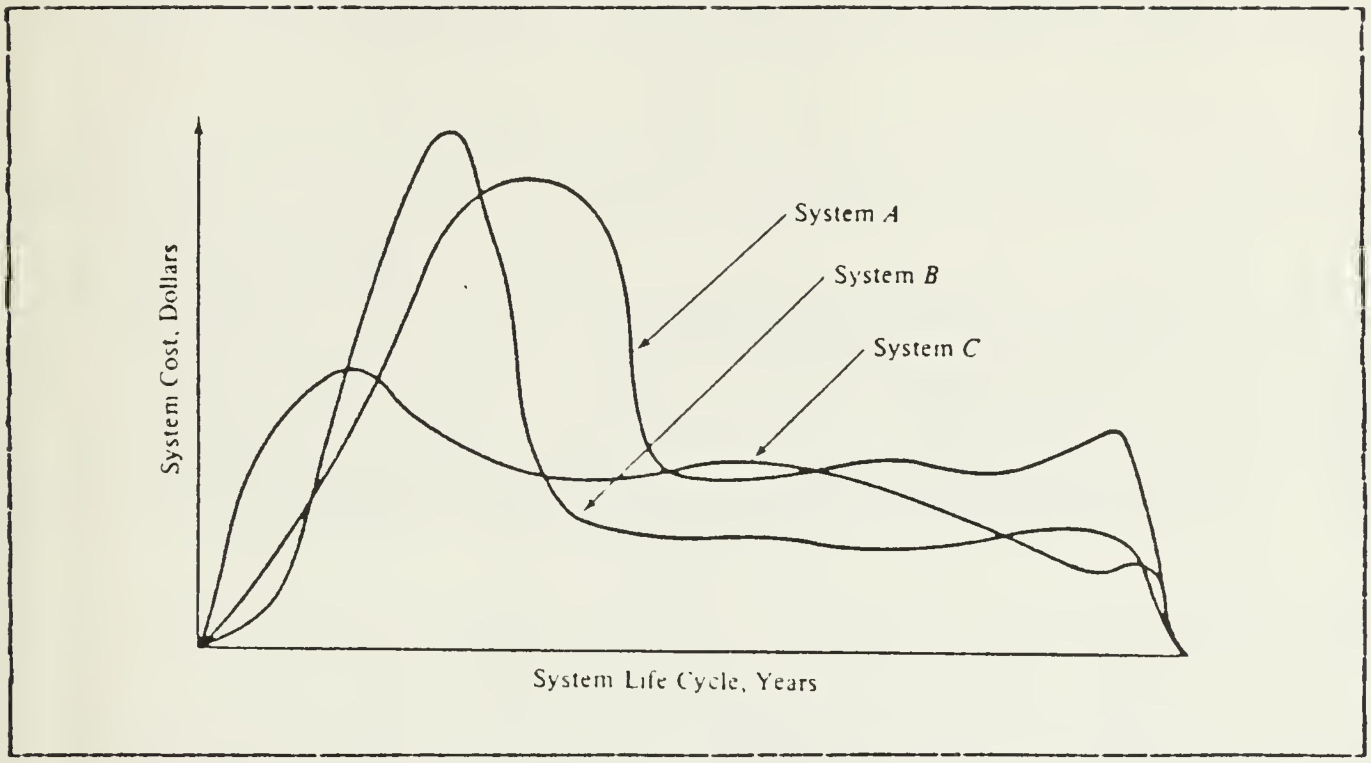

Figure 5.5 Life-Cycle Cost Profiles of Alternatives.

generally considered as the present time or now). Thus, the costs for each year in the life cycle (for each profile being evaluated) are discounted to the present value. Final decision can be made at the decision point in terms of the comparison of each present value, if each effectiveness remains same. [Ref. 28: pp. 68-77]

ROW	PRIME APPRD	DEFN REF	SYSTEM STRUCTURE* / COST ELEMENT	(1) FRAME	(2) PROPULSION	(3) GUIDANCE CONTROL/ COMMUNICATIONS	(4) FIRE CONTROL	(5) ARMAMENT	(6) PAYLOAD/ AMMUNITION	(7) ** (TO BE SPECIFIED)	(8) PECULIAR SUPPORT EQUIPMENT	(9) COMMON SUPPORT EQUIPMENT	(10) OTHER	(11) TOTAL	(12) PERCENT
1		1 0	RESEARCH AND DEVELOPMENT												
2	RDTE	1 01	DEVELOPMENT ENGINEERING												
3	RDTE	1 02	PRODUCIBILITY ENGINEERING AND PLANNING (PEP												
4	RDTE	1 03	TOOLING												
5	RDTE	1 04	PROTOTYPE MANUFACTURING												
6	RDTE	1 05	DATA												
7	RDTE	1 06	SYSTEM TEST AND EVALUATION												
8	RD OM	1 07	SYSTEM/PROJECT MANAGEMENT												
9	RD OM	1 08	TRAINING												
10	RD MC	1 09	FACILITIES												
11	RDTE	1 10	OTHER												
12		2 0	INVESTMENT												
13	PR MC	2 01	NON RECURRING INVESTMENT												
14	PROC	2 02	PRODUCTION												
15	PROC	2 03	ENGINEERING CHANGES												
16	PR OM	2 04	SYSTEM TEST AND EVALUATION												
17	PR OM	2 05	DATA												
18	PR OM	2 06	SYSTEM/PROJECT MANAGEMENT												
19	PR MC	2 07	OPERATIONAL/SITE ACTIVATION												
20	PR OM	2 08	TRAINING												
21	PR OM	2 09	INITIAL SPARES AND REPAIR PARTS												
22	PR OM	2 10	TRANSPORTATION												
23	PR OM	2 11	OTHER												
24		3 0	OPERATING AND SUPPORT COST												
25		3 01	MILITARY PERSONNEL												
26	MPA	3 011	CREW PAY AND ALLOWANCES												
27	MPA	3 012	MAINTENANCE PAY AND ALLOWANCES												
28	MPA	3 013	INDIRECT PAY AND ALLOWANCES												
29	MPA	3 014	PERMANENT CHANGE OF STATION												
30		3 02	CONSUMPTION												
31	PR OM	3 021	REPLENISHMENT SPARES												
32	OMA	3 022	PETROLEUM OIL AND LUBRICANTS												
33	PROC	3 023	UNIT TRAINING AMMUNITION AND MISSILES												
34		3 03	DEPOT MAINTENANCE												
35	OMA	3 031	LABOR												
36	PR. OM	3 032	MATERIEL												
37	OMA	3 033	TRANSPORTATION												
38	PROC	3 04	MODIFICATIONS MATERIEL												
39		3 05	OTHER DIRECT SUPPORT OPERATIONS												
40	OMA	3 051	MAINTENANCE CIVILIAN LABOR												
41	OMA	3 052	OTHER DIRECT												
42		3 06	INDIRECT SUPPORT OPERATIONS												
43	MP/OM	3 061	PERSONNEL REPLACEMENT												
44	MPA	3 062	TRANSIENTS PATIENTS AND PRISONERS												
45	OMA	3 063	QUARTERS MAINTENANCE AND UTILITIES												
46	MP OM	3 064	MEDICAL SUPPORT												
47	OMA	3 065	OTHER INDIRECT												
48			TOTAL SYSTEM COST (LESS EROA)												
49	EROA	4 0	EROA COST												
50			TOTAL SYSTEM COST (WITH EROA)												

100%

Figure 5.6 Army Life-Cycle Cost Matrix.

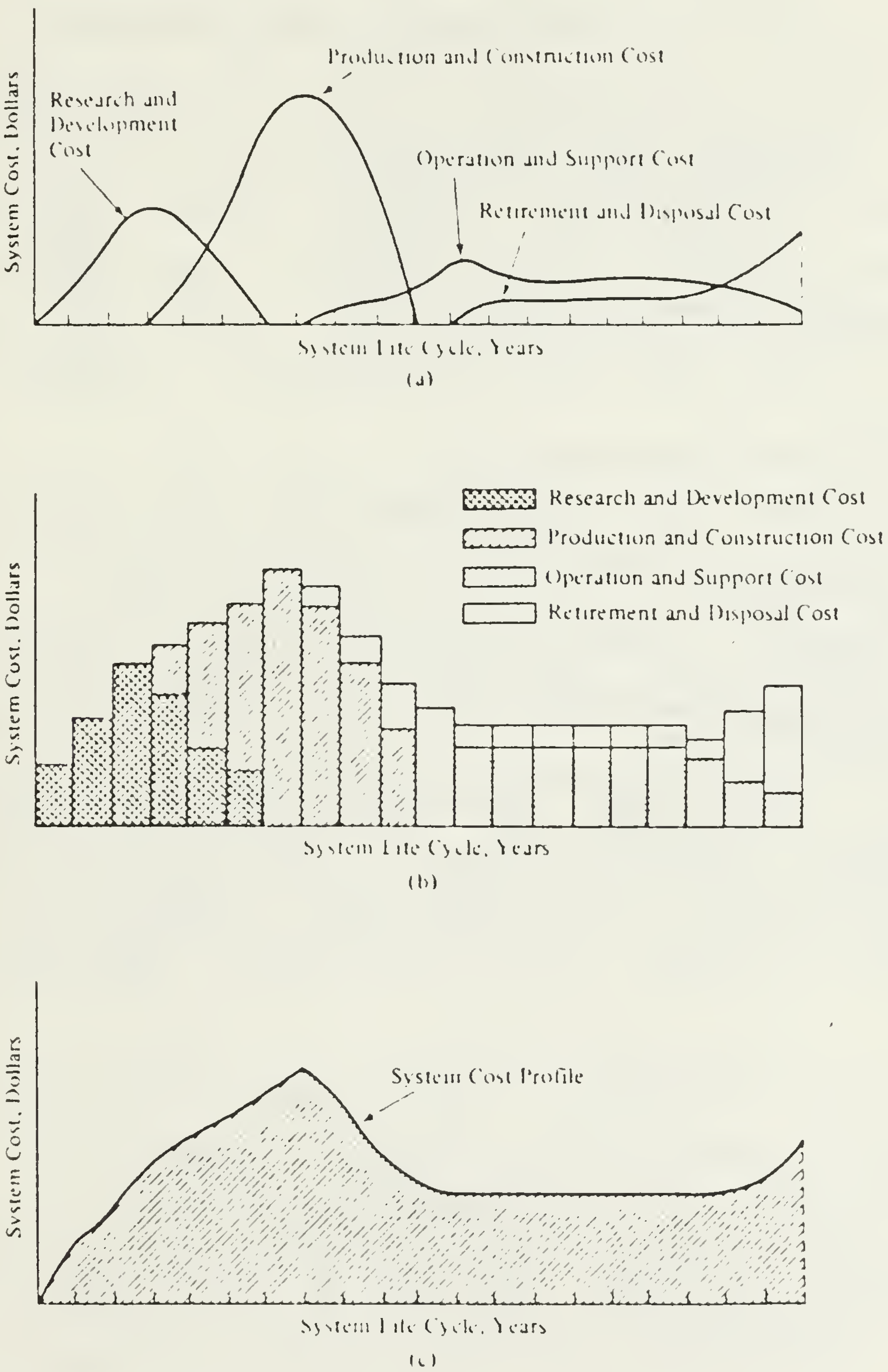

Figure 5.7   A Life-Cycle Cost Profile.

b. Research and Development (R&D) Costs

The term, "R&D cost", is generally defined to be the sum of all costs resulting from applied research, engineering design, analysis, development, test, evaluation and managing development efforts related to a specific weapon system. The R&D costs incurred during the acquisition process of a weapon system represent major commitments of resources. Clearly, these relatively large costs warrant comprehensive review during the acquisition process. Specific reasons why R&D cost estimates are needed are: [Ref. 65: p. 1.2]

1. To permit labor savings.
2. To permit trade-offs between life cycle phases.
3. To achieve better balance between equipment purchase and repair.
4. To perform better comparisons between new materiel systems.
5. To provide management visibility of critical resource requirements.

The R&D cost elements are listed in Table VIII with elements numbers to indicate first and second level of indenture elements. The second level elements sum to the first level elements of the R&D cost. [Ref. 65: pp. 2.0-2.2]

As a practical matter, the second level of R&D costs should be computed. Therefore, 10 general equtions are needed to compute each element of second level. Each equation illustrates the philosophy of parametric estimating and comprises several highly aggregated factors including one or more requirements factors and cost factors. For example, development engineering (1.01) equation is as follows:

$$\begin{array}{c}\text{Development}\\ \text{Engineering}\\ 1.01\end{array} = \begin{array}{c}\text{Average}\\ \text{cost per}\\ \text{man-year}\end{array} \times \begin{array}{c}\text{number of}\\ \text{engineering}\\ \text{man-year}\end{array}$$

TABLE VIII

Research and Development Cost Elements

Element Number	Cost Element
1.0	Research and Development Cost
1.01	Development Engineering
1.02	Production Engineering/Planning
1.03	Tooling
1.04	Prototype Manufacturing
1.05	Data
1.06	System Test and Evaluation
1.07	System/Project Management
1.08	Training Services and Equipment
1.09	Facilities
1.10	Other

Supporting each factor is the detailed work done by the analyst. For instance, the analyst may estimate the number of engineering man-years per equipment by using a statistical relationship, based on historical data from similar systems. The R&D cost documentation must take clear exactly what is being costed, where the factors come from, and how the results are calculated [Ref. 65: p. 6.1]. The R&D cost estimating equations (1.01 through 1.10) are presented in [Ref. 65].

c. Investment Costs

Investment costs occur during the production phase. The non-recurring costs of this category include tooling, support and test equipment, manufacturing planning, new facilities training and recruitment, while the recurring costs include manufacturing labor, material, inspection, and support equipment maintenance. These costs are charged directly to a particular part/equipment produced, while other costs, such as building maintenance, supervision, clerical personnel, and accounting costs are accumulated and allocated to each part/equipment as overhead. [Ref. 55: p. 189]

The investment cost elements are listed in Table IX with element numbers to indicate first and second level of indenture elements [Ref. 65: p. 2.5]. The second level elements sum to the first level elements of the investment.

TABLE IX

Investment Cost Elements

Element Number	Cost Element
2.0	Investment
2.01	Non-recurring investment
2.02	Production
2.03	Engeering changes
2.04	System test and evaluation
2.05	Data
2.06	System/project management
2.07	Operational/site activation
2.08	Training
2.09	Initial spares and repair part
2.10	Transportation
2.11	Other

The investment requirements initially stem from system operational data developed during advanced planning and conceptual design, and subsequently are refined through the system design process. The investment requirements also vary considerably depending on the type of system, available capacity in the producer's plant and supporting resource needs, management decisions pertaining to "make or buy", and so on. [Ref. 28: p. 260]

To compute The investment costs, 11 general equations are needed. These general equations are explained [Ref. 64].

d. Operating and Support (O&S) Cost

The term, "Life Cycle O&S Cost", is defined to be the sum of all costs resulting from the operation, maintenance and support (including personnel support) of the weapon system after it is accepted into the Army inventory. The O&S cost build-up begins when the first production equipment enters the active or reserve force structure either as operating unit equipment or combat crew training equipment. The O&S costs normally will be based on an assumed authorized strength with full authorized equipment in a peacetime environment. [Ref. 61: pp. 2.1-2.2]

The O&S costs incurred during the useful life of a weapon system may exceed its production cost. Clearly, these high costs warrant comprehensive review during the acquisition process. Several specific reasons why O&S cost estimates are needed are as follows: [Ref. 61: p. 1.1]

1. To permit personnel savings.
2. To evaluate the potential cost performance trade-offs and engineering changes.
3. To achieve better balance between equipment purchase and repair.
4. To perform better comparisons between materiel systems.
5. To provide management visibility of critical resource requirements.

The operating and support cost elements are listed in Table X with element numbers (3.xxx) to indicate first, second and third level of indenture elements [Ref. 61: p. 2.4].

The third level elements sum to the second level elements, the second level elements sum to the first level elements of the O&S costs. To compute O&S costs, 18 equations are needed. Each equation illustrates the philosophy of O&S cost estimating, in that the equations consists of several highly aggregated factors including one or more

TABLE X

Operating and Support Cost Elements

Element Number	Cost Element
3.0	Operating and Support Cost
3.01	Military Personnel
3.011	Crew Pay and Allowances
3.012	Maintenance Pay and Allowances
3.013	Indirect Pay and Allowances
3.014	Permanent Change of Station
3.02	Consumption
3.021	Replenishment Spares
3.022	Petroleum, Oil and Lubricants
3.023	Unit Training, Ammunition/Missiles
3.03	Depot Maintenance
3.031	Labor
3.032	Materiel
3.033	Transportation
3.04	Modifications, Materiel
3.05	Other Direct Support Operations
3.051	Maintenance, Civilian Labor
3.052	Other Direct
3.06	Indirect Support Operations
3.061	Personnel Replacement
3.062	Transients, Patients and Prisoners
3.063	Quarters, Maintenance/Utilities
3.064	Madical Support
3.065	Other Indirect

requirements factors and cost factors. The O&S cost estimating equations are explained in [Ref. 61: pp. 6.1-6.5].

For instance, Maintenance pay and allowances cost (3.012) shows the quantity of operational equipment, number of maintenance men per operational equipment, average annual cost per maintenance man, and the number of years of operation. Supporting each factor is the detailed work done by the analyst. The analyst may estimate the number of maintenance men per equipment by using a statistical relationship, or reliability data from prototypes. The O&S cost documentation must make clear exactly who and what is being costed, where the factors come from, and how the results are calculated. [Ref. 61: p. 6.0]

e. Retirement and Disposal Cost

Disposal of hardware is a one-time cost, and it is logically related to the acquisition of the item, even though it may be far removed in time. If disposal costs are addressed at all in a life-cycle cost estimate, they should be mentioned (together with a discussion of residual value) in the investment phase. [Ref. 61: p. 2.4]

f. Applying LCC for Decision-maker

This section explains a simple example for the acquisition decision process which the Army may face in these days. The data[42] utilized in this thesis is fictitious and serves only to provide a example of cost-effectiveness analysis.

Colonel Kim, head of the Attack Helicopters Mission Analysis Group(AHMAG) is trying to analyze possible armament changes for the Army's attack helicopter, because improvements in enemy vehicle hardening had created a requirement for improved air offensive capabilities in close support of troops in addition to other available weapons. The new system is named as the Attack Helicopter Close Support and Penetration System (THCPEN). At the present time, the Army helicopter units have consisted of four .50-caliber machine gun mounts per attack helicopter. Each of these guns could fire 300 rounds per minute (a sustainable rate) for a total of 1200 rounds per minute on target.

Three alternative improvements are under consideration. The present system is excluded in alternative consideration, because the Army needs strongly the improvement armament for the attack helicopter units. Three alternatives are as follows:

---

[42] Most of data are derived from the class material for the System Analysis course by Prof. Dan Boger in the NPGS.

1. Two .50-caliber pods with 4 barrels per pod. Each barrel could fire 200 rounds per minute giving a total of 1600 rounds per minute for the two pods. The .50-caliber round used in the pod had greater range, velocity, and penetrating power than the round currently used.
2. Two 25 millimeter (mm) cannons. This cannon had recently been developed and successfully tested by a well-known ordnance manufacturer. Each cannon could fire 150 rounds per minute for a total of 300 rounds per minute. This cannon had greater range and destructive power than either of the other two gun systems.
3. Two Stubby Rocket (STUBROC) pods. Each pod held 42 rockets which could be fired either singly or in groups/sticks. In general, the STUBROC had similar range and destructive power to the 25mm cannon but the reliability of its firing mechanism was suspect.

Col. Kim was sitting at his desk going over a report sent to him from another analyst for Attack Helicopters Offensive Modifications. The report took issue that two 25mm would lead to a greater increase in effectiveness than the .50-caliber or the STUBROC.

The effectiveness, measured by the probability of enemy vehicle destruction, is as follows:

1. Two .50-caliber pods : .171
2. Two 25mm cannons : .236
3. Two STUBROC pods : .207

Col. Kim agreed that under the assumptions made by another analyst, the 25mm cannon would increase the THCPEN system's effectiveness more than the other alternatives. However, he thought the cost-effectiveness analysis was better method for the modification decision. At that time, Col. Kim also received another report, which was made by Mr. Lee, civilian analyst. Mr. Lee estimated the procurement costs of a squadron for the alternatives as follows:

1. Two .50-caliber pods: $4.0 million
2. Two 25mm cannon : $6.5 million
3. Two STUBROC pods : $12.0 million

Mr. Lee then took the ratio of costs to effectiveness for each alternatives:

1. Two .50-caliber pods: $4.0 million/.171 = 23.4
2. Two 25mm cannons : $6.5 million/.236 = 29.7
3. Two STUBROC pods : $12.0 million/.207 = 58.0

Since the .50-caliber pod had the lowest cost per unit of effectiveness, Mr. Lee recommended the two .50-caliber pods rather than the two 25mm cannons and two STUBROC.

After going over Mr. Lee's report, Col. Kim thought that the attempt to determine the cost-effectiveness of the proposed alternatives was a good idea but there were some problems in calculating costs. Mr. Lee considered only the procurement cost of each alternative. So, Col. Kim decided to perform a life-cycle cost estimating methodology on the alternatives. The R&D cost is considered as sunk cost, therefore, Col. Kim estimated the two first-level costs of each alternatives: Investment costs and Operation and Support costs.

The investment costs were estimated as follows:

1. Procurement and installation of two .50-caliber pods: $10.5 million
2. Procurement and installation of two 25mm cannons : $15.0 million
3. Procurement and installation of two STUBROC pods : $26.0 million

To compute the O&S costs, the following data were collected. The two .50-caliber pods would require 30 men for armament and maintenance, the two 25mm cannons would require 6 men and the two STUBROC pods would require 24 men. Manpower cost of each alternative was derived from above data.

The spares and repair parts estimate for the STUBROC was derived from a CER of annual costs of spares and repair parts for various Air-to-Surface rocket systems plotted as a function of the acquisition cost of the original system. A line was fitted to the points for prediction purposes:

$$Y = \frac{1}{100} X + 20,000$$

Since the procurement cost of STUBROC is $ 12.0 million, the cost of spares and repair parts was estimated as $ 140,000. The spares and repair parts costs for the .50-caliber and 25mm cannon were derived from another existing systems. In addition, Col. Kim estimated inventory costs, transportation and storage, training, publications and maintenance(depot and intermediate).

A six year life cycle, a 10% interest rate and a 6% inflation rate were assumed. Costs of each alternatives are shown in Table XII. Table XII gives the projected cash flow for the three alternative systems.

Total present value cost are represented in Table XI. Thus, it seems to Col. Kim that on the basis of minimum total life-cycle costs and the highest effectiveness, the 25mm Cannons would be the best alternative.

TABLE XI

Total Present Value Costs

	.50-cal	25mm	STUBROC
Total Cost	18,668	17,921	32,335

TABLE XII

Present Value Comparison

< .50-caliber > (thousand)

Year	Cash Flow			Discount factor	Present Value	
n	Invest	O & S	Inf(6%)	10 %	Invest	O & S
0	10,500			0.0000	10,500	
1		1,550	1,643	0.9091		1,494
2		1,545	1,736	0.8264		1,435
3		1,545	1,840	0.7513		1,382
4		1,545	1,951	0.6830		1,333
5		1,545	2,068	0.6209		1,284
6		1,548	2,196	0.5645		1,240
tot	10,500	6,889	11,434		10,500	8,168

< 25mm Cannon >

Year	Cash Flow			Discount factor	Present Value	
n	Invest	O & S	Inf(6%)	10 %	Invest	O & S
0	15,000			0.0000	15,000	
1		570	684	0.9091		622
2		535	601	0.8264		497
3		530	631	0.7513		474
4		530	669	0.6830		457
5		530	709	0.6209		440
6		538	763	0.5645		431
tot	15,000	3,260	4,057		15,000	2,921

< STUBROC >

Year	Cash Flow			Discount factor	Present Value	
n	Invest	O & S	Inf(6%)	10 %	Invest	O & S
0	26,000			0.0000	26,000	
1		1,230	1,304	0.9091		1,118
2		1,200	1,348	0.8264		1,114
3		1,190	1,417	0.7513		1,065
4		1,190	1,502	0.6830		1,025
5		1,190	1,598	0.6209		989
6		1,195	1,695	0.5645		957
tot	26,000	7,195	8,864		10,500	6,735

(Inf: Inflation Rate)

VI. CONCLUSION AND RECOMMENDATIONS

Our final goal on the Korean peninsula is to keep peace first, and then to establish "reunification" peacefully. To reach this goal, the Republic of Korea has tried with great effort. However, the environment of ROK has changed dramatically according to the attitudes of North Korea and the relationship between neighboring super-powers.

The ROK has some difficulties such as the big military imbalance, uncertainty of US defense policy, geography and logistics. How do we overcome these problems and then reach our final goal? Possible alternatives are many, but the most challenge is to improve military logistics. The reason is that one of the weakness in the ROK military is logistics. After the Korean War, considerable efforts and studies have been devoted toward the development of credible strategic and tactical doctrine. Throughout this process, military logistics has been relegated to a category of secondary importance. Fortunately, these days the ROK military leaders has begun to recognize the importance of logistics.

What are needed urgently for the improvement of the ROK military logistics in current situations are:

1. First of all, the military commanders and planners, especially in the higher ranking levels, must understand the concept of modern military logistics more fully. Until now, the idea that military logistics supports the weapon or that, in fact, logistics provides "support" still prevails. These attitudes for military logistics have been become the big obstacle in improving military force. Now, it is time to discard these obsolete attitudes. Military

logistics is the cornerstone of the military forces in that: (1) It provides combat forces with the capability of waging war; (2) It is very related to the nation's economic growth; (3) It provides tangible evidence of military power in deterring a military threat; (4) It limits and shapes the strategies and tactics that can be implemented during the waging of war; (5) Its effectiveness directly impacts the cost and capability of military forces; (6) It indicates that a valid assessment of the enemy's "logistics capability" will provide a theatre commander with a great deal more information than only knowing the number and placement of their forces.

2. ROK Army has to concentrate on the development of ILS system which can be considered to increase the operability of forces and enhance their readiness. ILS comprises all the support considerations necessary to assure the effective and economical support of a system or equipment at all levels of maintenance for its programmed life cycle. Development of ILS for a new system or equipment shall be initiated concurrently with the performance requirements or at the earliest possible time in the conceptual phase. Moreover, the evolution of logistic support, that is the integration of its elements, shall be the result of progressive system analysis of the plan for use and the plan for support and the indicated trade-offs between these plans. Therefore, the ROK Army can take advantage of ILS system as a management tool in developing life-cycle logistics support during the acquisition cycle. Also, it is very important to emphasize the training of ILS manpower and the teamwork between customer units and direct support unit including the industrial base.

3. The ROK Army might be equipped by weapon systems through the various acquisition methods; self-production, co-production, direct purchase, cooperative production, military aid, and mixed type. The best strategy depends on the situation of ROK military. The ROK military has concentrated on self-production since 1976, even if it has some disadvantages such as more R&D and production cost, more time, and higher failure probability during R&D. But, it has some advantages such as techno-economic effects to the other industries and inspiration of self-defense spirit. In developing the acquisition strategy of self-production, the ROK Army must decide the appropriate alternatives in terms of cost-effectiveness analysis. In this case, cost estimating plays an important role. The apparent fact is that the operating and support costs of any weapon systems are increasing at an alarming rate and often exceed the cost of system acquisition. This requires that the life-cycle cost estimating methodologies must be recognized in today's acquisition management policy in the ROK Army. The best decision can be made based on the amount of data available to the analysts at the moment. Therefore, organization, data and analysts are essential factors in order to do cost estimates successfully. In addition, we need a complete, detailed and fully documented estimate of system life-cycle cost.

There are many more factors that must be considered by the ROK Army in order to improve the military power. However, the above recommendations should be examined in depth and accepted properly by the ROK Army. As a result, we hope this thesis helps the ROK Army to improve the logistics field in peacetime as well as wartime.

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